SECTION 6 - GEARCASE

General Precautions

Before performing any service work on the gearcase, read and understand the Service Safety section at the beginning of this manual.

Full servicing of the gearcase requires manufacturer special tools. Follow all special tool requirements as specified. Substituting special tools with those not provided by the manufacturer may result in severe personal injury, equipment or engine damage, or faulty service work.

Perform bearing removal and installation operations exactly as specified to avoid damage to the bearing or housing during pressing operations.

Replace locking fasteners when their locking feature becomes weak.
Use only factory replacement parts.

When using compressed air to clean or dry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa / 1.76 kg/cm'].

SERVICE SPECIFICATI0NS

Special Torque Values – Raider 40

Description	Torque In-lb (ft-lb) N-m Kg-m	Thread – locker
Propeller Nut	(21.7 - 28.9) 29.4 - 39.2 3.0-4.0	–
Pump case Bolts	41-55 4.6-6.2 0.47 - 0.64	Locte 242
Bevel Gear B Nut/Bolt	(17.3 - 18.8) 23.5 - 25.5 2.4 - 2.6 Bolt	–

Special Equipment Required

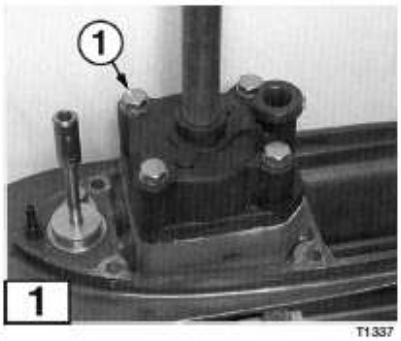
Part Name	Part Number	40
Bevel Gear A Bearing Puller Ass'y	3A3-72755-0	•
Bearing Outer Press Rod	3B7-72731-0	•
Bearing Outer Press Plate	353-72732-0	•
Bearing Outer Press Plate	346-72732-0	
Bearing Outer Press Guide	346-72733-0	•
Bevel Gear A Set Tool	346-72719-0	
Bevel Gear A Set Tool	3C8-72719-0	•
Backlash Measuring Tool Kit	3B7-72740-0	
Backlash Measuring -Tool Sub-Ass'y	*369-72730-0	
Backlash Measuring Tool Arm	*369-72727-0	
Backlash Measuring Tool Arm	*3B2-72727-0	
Backlash Measuring Tool Kit	3C8-72234-0	•
Measuring Tool Shaft	*345-72723-0	•
Backlash Measuring Tool Plate	*3A3-72724-0	•
O-Ring, 2-9	*332-60002-0	•
Backlash Measuring Tool Collar	*350-72245-0	
Backlash Measuring Tool Collar	*346-72245-1	
Backlash Measuring Tool Collar	*353-72245-1	•
Nut, 10P1.5	*930191-1000	• (2)
Conedisk Spring, d=12	*3B7-72734-0	• (3)
Clamp Ass'y Backlash Measur'g Tool	3B7-72720-0	•
Bolt	910191-0625	• (4)
Dial Gauge Plate	3B7-72729-0	•
Shimming Gauge	346-72250-0	
Shimming Gauge	3C8-72250-0	•
Thickness Gauge	353-72251-0	•

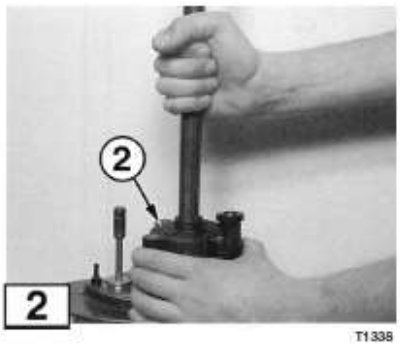
General Equipment Required

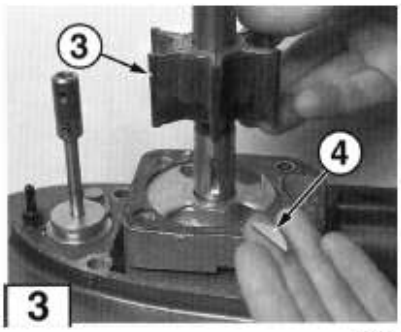
TorqueWrench, 0- 150 in-lb[0 - 17 N-m / 0- 1.7 kg-m]
TorqueWrench, 0 - 150 ft-lb [0 - 200 N-m / 0 - 20 kg-m]
Dial Gauge, minimum scale0.0001 in [0.01 mm]
Gearcase Pressure Tester, *Stevens® S-34 or equivalent*
Gearcase Vacuum Tester, *Stevens® V-34 or equivalent*
Seal Pullers
Seal hlStallers
Heat Gun

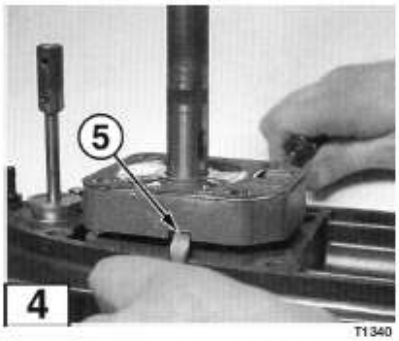
Consumables Required

Threadlocker, *Loctite® 242*
Gasket Sealant, *Permatex® High Tack Gasket Sealant*
Anaerobic Gasket Maker, *Loctite® 518*
Silicone Spray Lubricant, *Permatex® Silicone Spray Lubricant*
Genuine Grease or Equivalent Friction Surface Marine Grease
Isopropyl Alcohol
Cleaning Solvent
Engine Lubricant, *Genuine engine oil or NMMA certified TC-W3 oil*
Gear Lubricant, *Genuine gear oil or API grade GL5, SAE #80 - #90*
Cleaning Pads, *Scotch-Brite® Abrasive Pads*
Gasket Remover









WATER PUMP

If the engine has been run without water for any length of time, the water pump should be serviced with a water pump repair kit. Use the following procedures to install the repair kit.

Removal

1. Remove the gearcase. See Gearcase, this section.

1 2. Remove water pump mounting bolts **(1)**.

2 3. Hold upper pump case **(2)** securely and rotate driveshaft clockwise to free impeller from upper pump case.

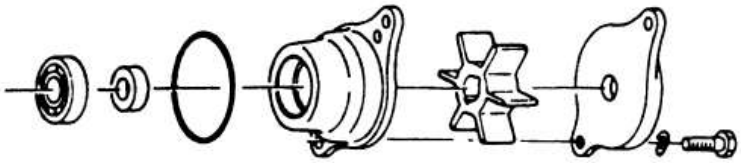
⚠ CAUTION

Do not rotate driveshaft counterclockwise. Doing so will bend impeller fins in wrong direction and may weaken or damage the impeller.

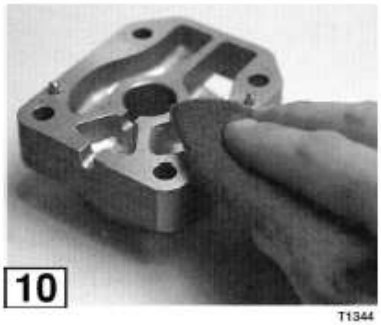
3 4. Slide upper pump case off driveshaft and remove pump impeller **(3)** and impeller key **(4)**.

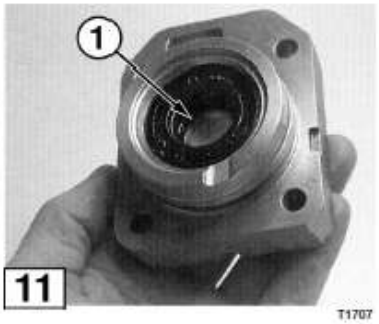
4 5. Insert a screwdriver in each lower pump case notch **(5)** and gently pry upward to remove. Slide lower pump case off driveshaft.

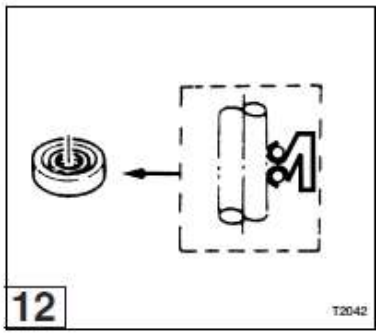
Water Pump Assembly



1. Disassemble the water pump component as illustrated and verify the kit parts match the originals before discarding old parts.







10 2. Remove all gasket residue from lower pump case with abrasive cleaning pads and gasket remover. Do not scrape the gasket surface with metal scraper. Thoroughly clean all components with isopropyl alcohol and dry with lou pressure compressed air.

3. Inspect the upper and lower pump cases for signs of melting and cracks. Replace as needed.

11 4. Examine lower pump case oil seals **(1)** for signs of damage and deterioration.

12

NOTE

If necessary to replace seals, use appropriate size seal puller and installer to avoid damaging new seals and seating surfaces in lower pump case. Apply silicone spray lubricant to seals and install so lips face direction indicated.

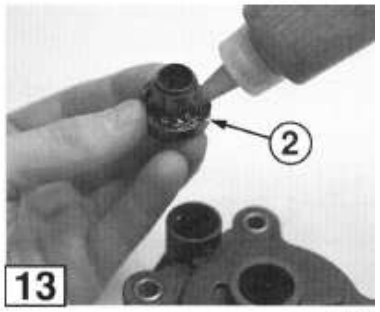
13 5. Apply anaerobic gasket maker to seating surface of water pipe lower seal **(2)**.

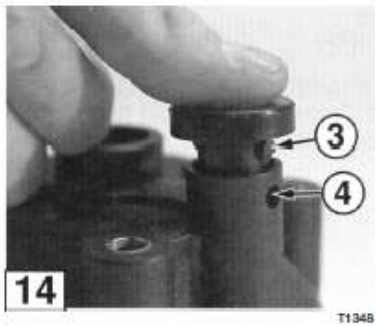
14 6. Install seal in upper pump case so locking tabs **(3)** align with holes **(4)**.

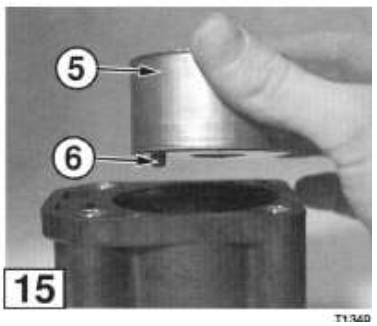
15 7. Slide pump case liner **(5)** partially into upper pump case housing so locking tab **(6)** is aligned with notch in housing.

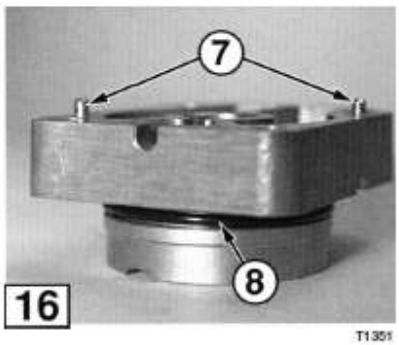
NOTE

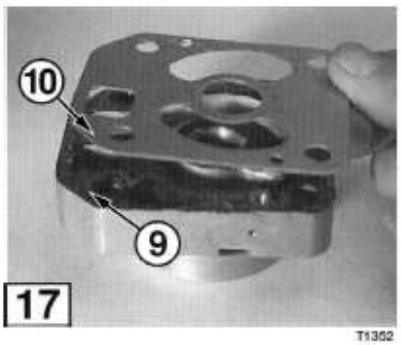
Pump case liner must be flush with flanged surface of upper pump case. If not, remove liner and re-align locking tab with notch in upper pump case housing.

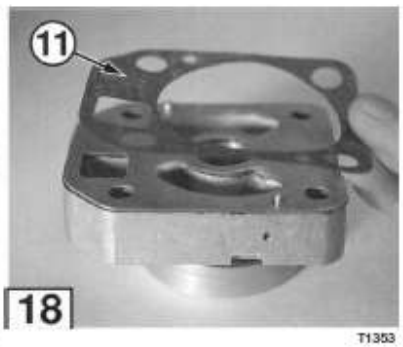








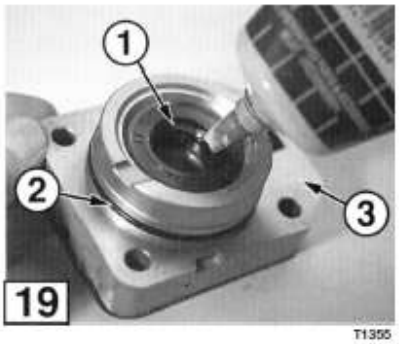




16 8. Install lower pump case dowel pins **(7)** if removed and o-ring **(8)**.

17 9. Apply gasket sealant to both sides of guide plate gasket **(9)**. Mount gasket and guide plate **(10)** on lower pump case.

18 10. Apply gasket sealant to guide plate side of upper pump case gasket **(11)**. Mount gasket on guide plate.



Installation

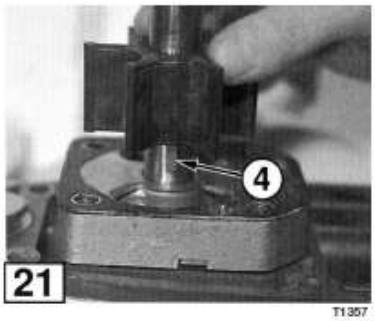
19 1. Apply a light coating of genuine grease or equivalent friction surface marine grease to the lower pump case driveshaft passage, oil seal lips **(1)**, and o-ring **(2)**. Apply an aerobic gasket maker to flanged surface **(3)** to provide adequate seal between lower pump case and gearcase.

20 2. Slide lower pump case down driveshaft and seat into position on gearcase.

3. Slide the impeller down the driveshaft onto lower pump case.

21 4. Insert impeller key **(4)** in driveshaft and align impeller slot with key. Hold the impeller key in place and push impeller down until seated in position.

22 5. Lubricate the impeller blades with soapy water and slide upper pump case down driveshaft. Hold pump case securely and push downward while rotating driveshaft clockwise to seat the impeller.



⚠ CAUTION

Do not rotate driveshaft counterclockwise. Doing so will bend impeller blades in wrong direction and may weaken or damage the impeller.

6. Ensure upper pump case is aligned and fully seated on the dowel pins. Hold the upper pump case in position and rotate driveshaft clockwise to ensure free movement.

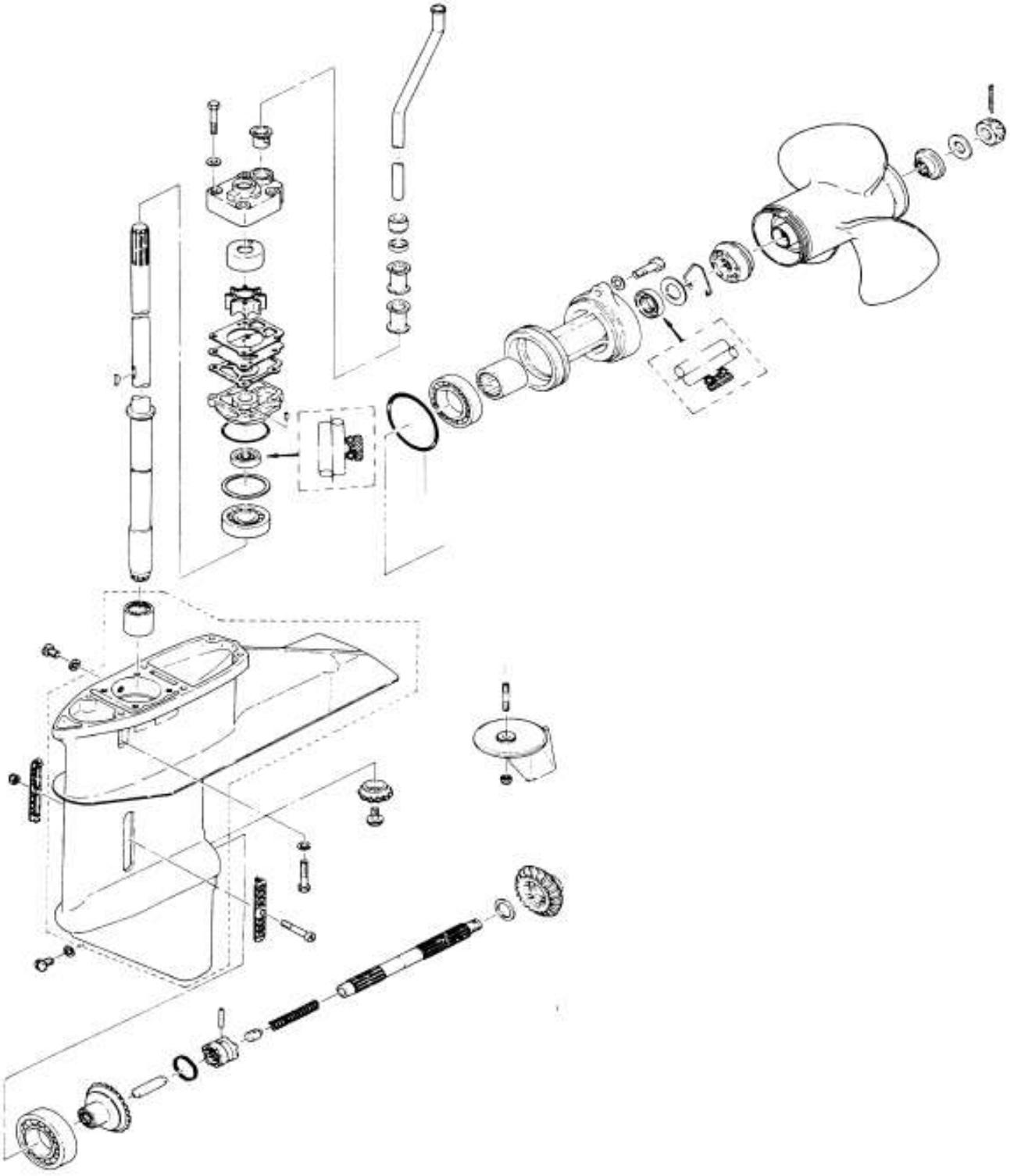
⚠ CAUTION

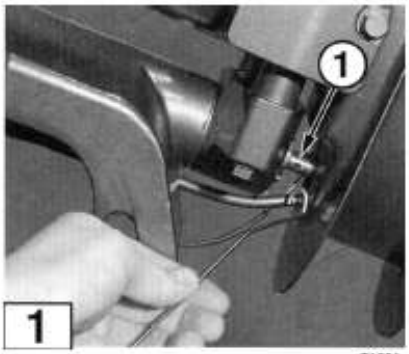
Make sure impeller blades are not caught or pinched between upper and lower pump cases when upper pump case is fully seated.

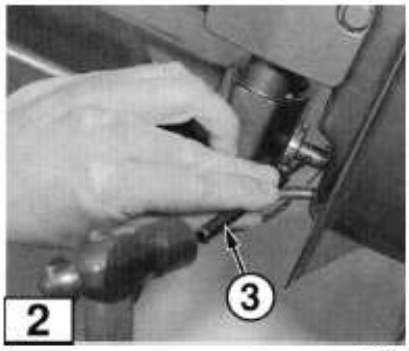
23 7. Apply genuine grease or equivalent friction surface marine grease to neck portion of water pump mounting bolts. Install the bolts.

8. Install the gearcase. See Gearcase, this section.

GEARCASE







Removal

⚠⚠ WARNING

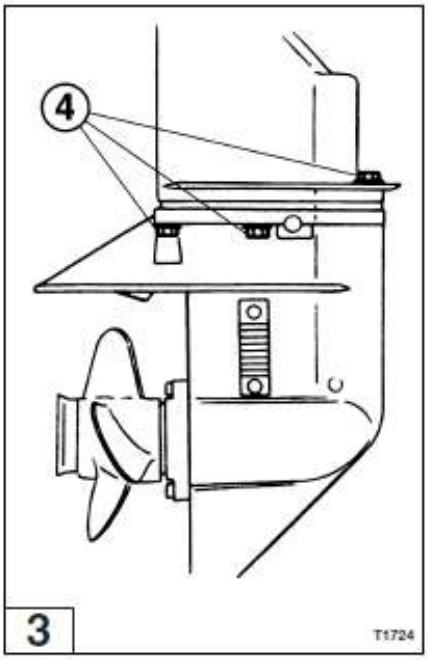
Ignition system must be disabled to prevent accidental engine start-up during removal of the gearcase.

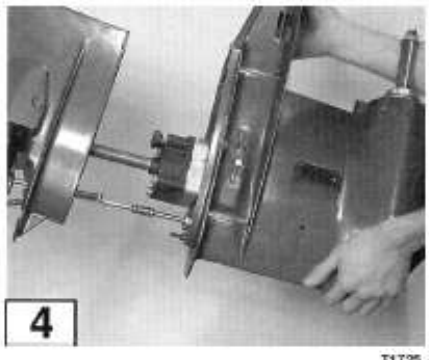
1. 1. Place engine in FORWARD gear so shift rod joint **(1)** is accessible.

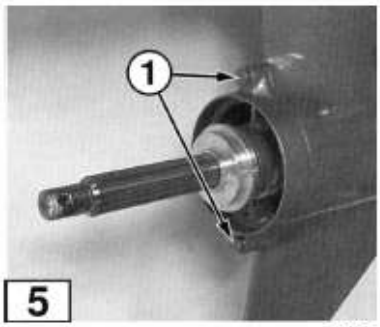
2. 2. Use spring pin tool A **(3)** (Part No. 345-72227-0) to remove upperspring pin from shift rod joint. Discard the spring pin.

3. 3. Remove gearcase mounting bolts **(4)** from both sides of gearcase.

4. 4. Separate gearcase from driveshaft housing.







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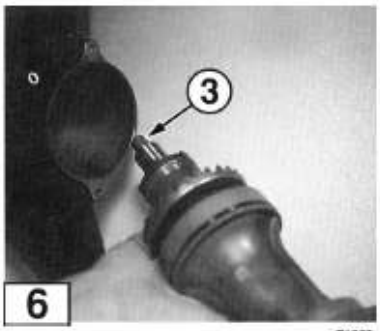

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Disassembly

⚠ CAUTION

Gearcase must be secured in a suitable holding fixture during disassembly.

1. Drain all gearcase oil into a container and inspect the oil for metal chips.

NOTE

Small metal fragments may indicate normal wear of gears, bearings, and shafts. Large metal chips usually indicate extensive internal damage. Record your observations for future reference when inspecting internal components.

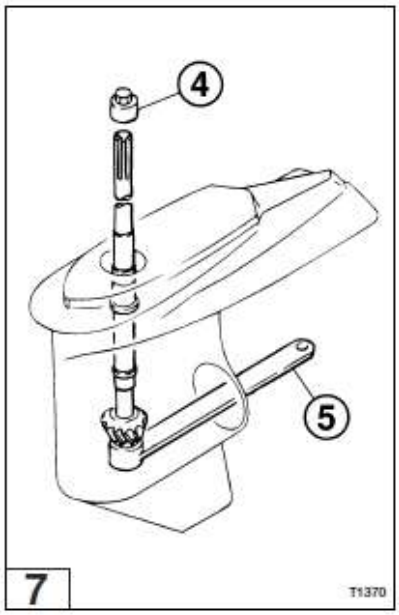
2. Remove the water pump and install a water pump repair kit if gearcase has been in service for any length of time. See Water Pump, this section.

3. Remove propeller mounting nut, washers and propeller.

5 4. Remove propeller shaft housing bolts **(1)**.

6 5. Remove propeller shaft and housing from gearcase. Make sure clutch push rod **(3)** is also removed. The push rod and spring may "pop" out with removal. Set the assembly aside.

7 8 6. Install socket **(4)** (Part No. 9.9/15/18: 350-72232-0, 25/30: 346-72232-0, 40: 345-72232-0) and wrench **(5)** (Part No. 346-72231-0). Hold bevel gear B nut with wrench and turn driveshaft counterclockwise to loosen the nut. Remove bevel gear B **(6)** and nut **(7)** from gearcase.



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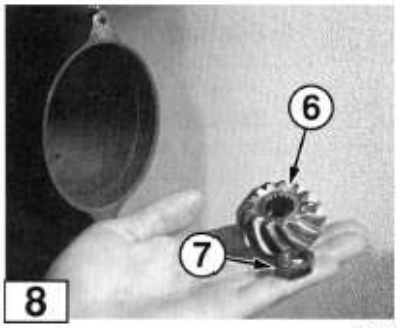

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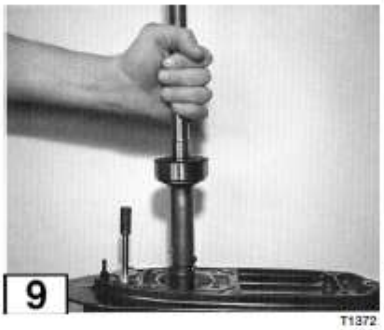
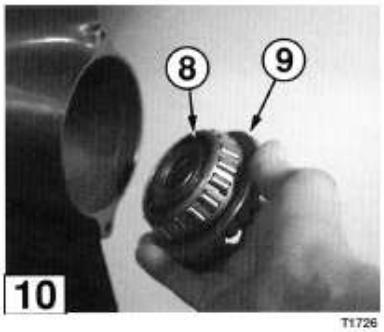
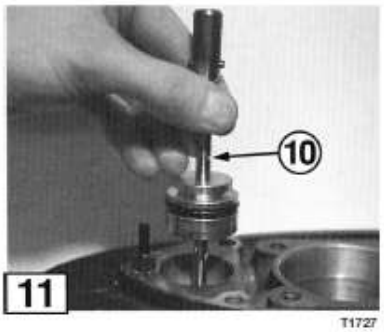






9 8. Lift the driveshaft from the gearcase and set it aside.

10 9. Reach inside gearcase and remove roller bearing **(8)** and bevel gear A **(9)**.

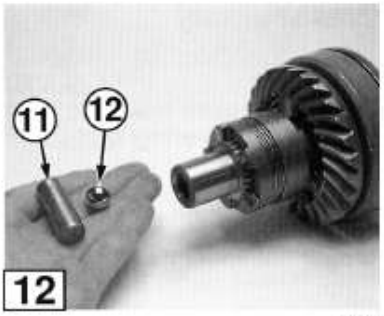
NOTE

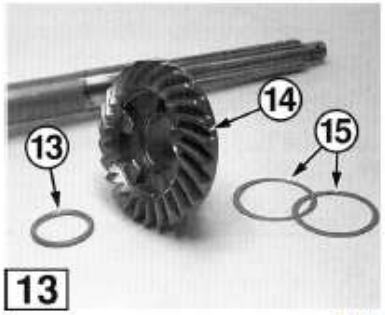
Taper bearing for bevel gear A is only used on Model 40.

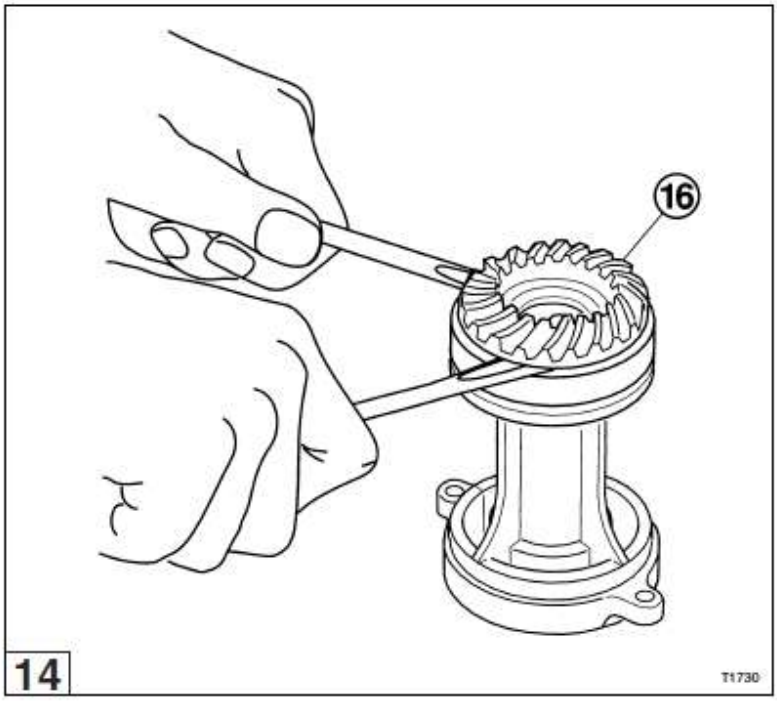
11 10. Remove the stopper and lift cam rod **(10)** from gearcase. Fullydisassemble the cam rod components, including the cam rod bushing internal and external o-rings.

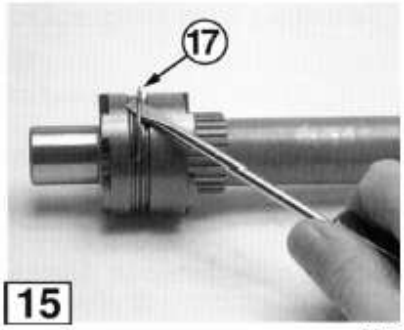
12 11. Remove clutch push rod **(11)** and ball **(12)** from propeller shaft. Pull propeller shaft out of housing.

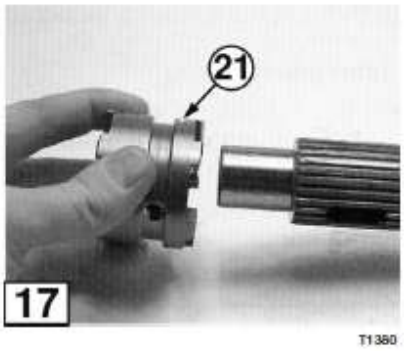
13 12. Remove washer **(13)**, bevel gear A **(14)**, and all shims **(15)** (25/30 and 40) from propeller shaft.

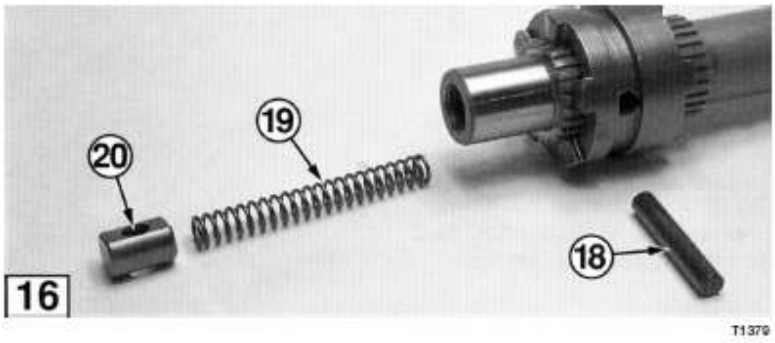












14 13. Remove bevel gear C **(16)** from the propeller shaft housing.

15 14. Insert screwdriver under one end of clutch pin snap spring **(17)**. Remove spring from groove by unwrapping it from clutch. Discard the spring.

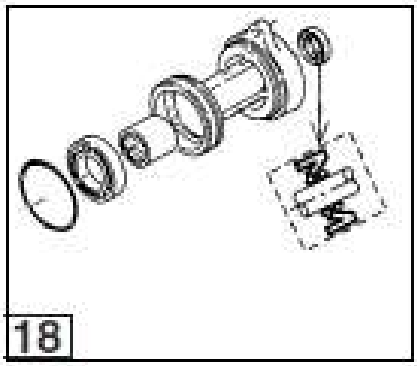
16 15. Place propeller shaft open end against bench surface and push out clutch pin **(18)**. Remove clutch spring **(19)** and spring holder **(20)**.

⚠⚠ WARNING

Wear safety glasses and DO NOT hold open end of propeller shaft towards face or body when removing clutch pin. Clutch spring and spring holder come out with great force.

17 16. Pull clutch **(21)** off propeller shaft.

Cleaning and Inspection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NOTE

All worn, damaged, and missing pails must be replaced.

1. Discard the clutch pin snap spring and all seals and o-rings that have been removed.

2. Clean all gearcase components with solvent and dry with low pressure compressed air. After cleaning, apply specified gear oil to all internal components to prevent rusting.

3. Perform the following inspections:

Gearcase Housing

- Inspect internal and external surfaces of housing for cracks and other damage. All threaded holes must be undamaged and free of corrosion and sealing agents.
- Checkthe sacrificial trim tab ford amage and erosion. See Anodes - Inspection and Testing in Section 2.
- Inspect the water intake screens for damage and blockage. If screens cannot be fully cleaned, replace them.

Propeller and Shaft

- Verify the propeller is true and free of nicks, chips, and other damage that will affect performance. Inspect the thrust washer and mounting hardware for damage.
- Check the propeller shaft threads and splines for wear and damage.

Propeller Shaft Housing

18 Examine propeller shaft housing and components for wear, damage, and deterioration. If necessary, disassemble and repair as needed. See Gearcase Repair Procedures, this section.

Driveshaft

- Check driveshaft threads and splines for wear, chips, and cracks. Severe spline wear or the appearance of spline "twisting" indicates the gearcase or exhaust housing has been distorted, possibly by impact damage.
- Bearing(s) must be free of damage, corrosion, and discoloration. Replace bearing(s) as required. See Gearcase Repair Procedures, this section.

All Internal Components

Inspect all internal components for signs of wear, chipping, pitting, distortion, and discoloration due to improper lubrication. Special attention to the following:

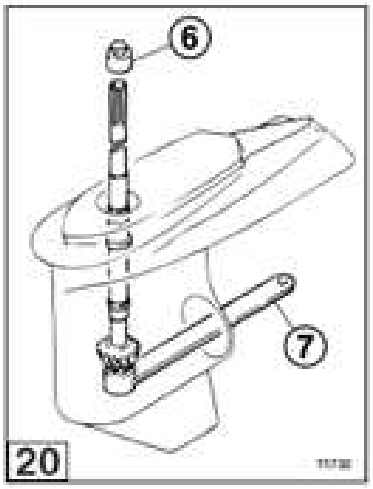
- Check the bevel gear A tapered roller bearing outer race. If damaged or corroded, replace both the race and the bearing. See Gearcase Repair Procedures in this section.
- Inspect clutch and gear teeth and the clutch cam for chips and signs of metal transfer. Replace parts as needed.

Assembly

1. Install new gearcase needle bearing, bevel gear A & B roller bearing and outer race, and driveshaft bearing(s) if any of these parts were removed. See Gearcase Repair Procedures, this section.

2. Secure gearcase in holding fixture with water pump side facing upward.

19 3. Apply Loctite 242 to the thread of bevel gear B nut (3). Slide bevel gear B (4) onto driveshaft (5) as shown from propeller shaft side of gearcase. Hand tighten nut (3) to secure the gear in place.



NOTE

Before applying Loctite 242, remove all grease from tapered portion of bevel gear B and driveshaft with solvent, and thread of driveshaft and bevel gear B nut also.

4. Install specified socked (6) Part No. 345-72232-0 and wrench (7) (Part No. 346-7223-1-0). Hold bevel gear B nut with wrench and turn driveshaft clockwise to tighten the nut. Torque bevel gear B nut to specification

5. Perform all adjustment steps before proceeding. See Adjustments, this section.

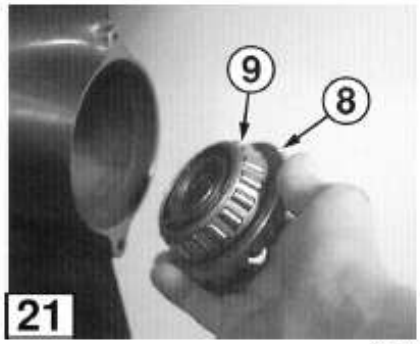
⚠ CAUTION

Failure to perform the adjustment steps may result in poor engine performance, premature wear of parts, or severe damage to gearcase components.

6. Install the water pump. See Water Pump, this section.

NOTE

Make sure all necessary adjustment shims are installed on driveshaft bearing before installing lower pump case.

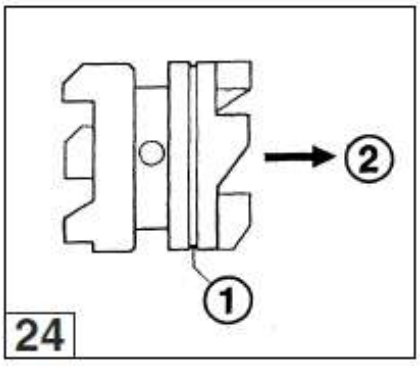


21 7. Install bevel gear A **(8)** so tapered roller bearing **(9)** is seated in outer race.

22 8. Replace cam rod bushing internal o-rings **(10)** and external o-ring **(11)**. Coat the internal o-rings and inner surface of bushing with specified gear oil. Then fully assemble the cam rod components.

23 9. Apply genuine grease or equivalent friction surface marine grease to the exterior of the cam rod bushing and o-ring.

10. Insert the cam rod into the cam rod port on the gearcase and seat the bushing. Install stopper with stopper bolt.

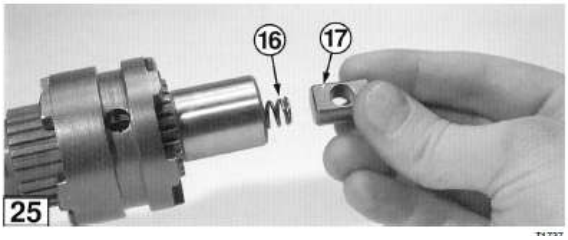


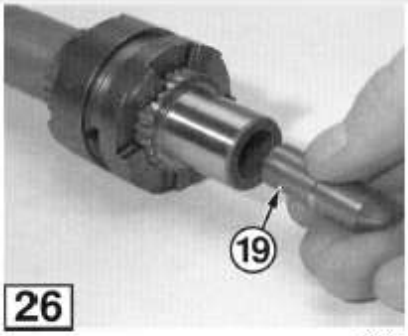
24 11. Align hole in clutch with slot in propeller shaft. Slide clutch onto shaft so the side with the groove **(1)** faces the side with bevel gear A **(2)**.

CAUTION

The clutch is not symmetrical (except 5 HP). If installed backwards, clutch and gears will be damaged.

25 12. Insert clutch spring **(16)** and install spring holder **(17)** so hole in spring holder is aligned with clutch hole.





26 T2045

27 T1739

28 T1740

26 13. Install clutch push rod **(19)** so tapered end faces bevel gearA.

27 14. Compress the clutch spring by applying pressure to push rod **(19)**. Align the holes of the clutch and spring holder and insert clutch pin **(20)**.

⚠ CAUTION

Wear safety glasses and DO NOT hold spring end of propeller shaft towards face or body when compressing the clutch spring.

28 15. Install new clutch pin snap spring **(21)** using the clutch pin snap tool. Do not reuse old snap Spring.

Part number of clutch pin snap tool

40 : 345-72229-0

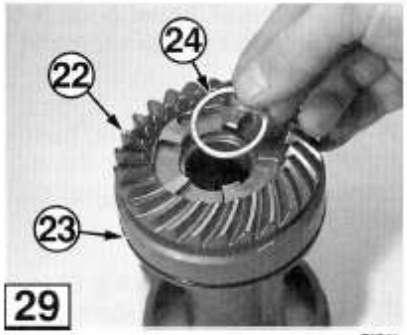
⚠ CAUTION

DO NOT reuse clutch pin snap spring (21), it must be replaced. Reusing clutch pin snap spring may cause severe damage to gears and other components.

29 16. Make sure all necessary adjustment shims are installed on bevel gear C **(22)** and install gear onto propeller shaft housing **(23)**. Install washer **(24)** onto bevel gear.

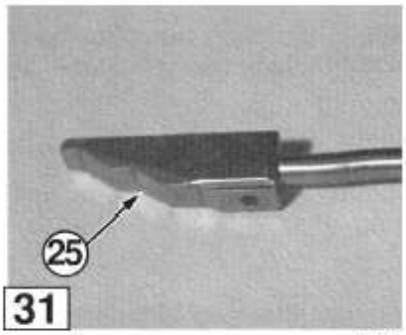
30 17. Apply genuine grease or equivalent to the propeller shaft housing o-ring and oil seal. Slide the propeller shaft into the propeller shaft housing.

31 18. Lift the cam rod to the fully UP position and verify through the gearcase opening that clutch cam beveled side **(25)** faces gearcase opening.

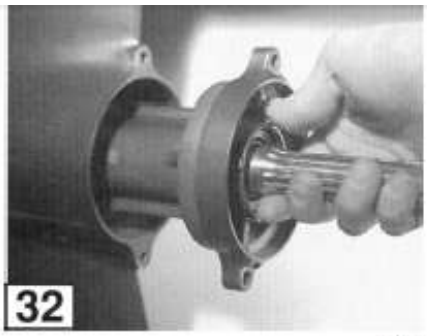


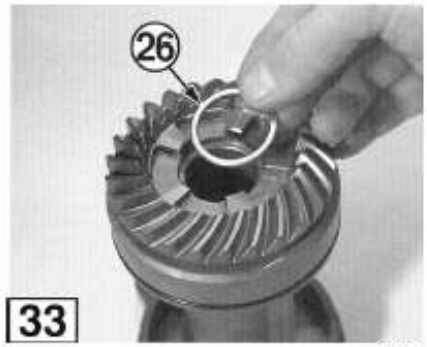
29 T1741

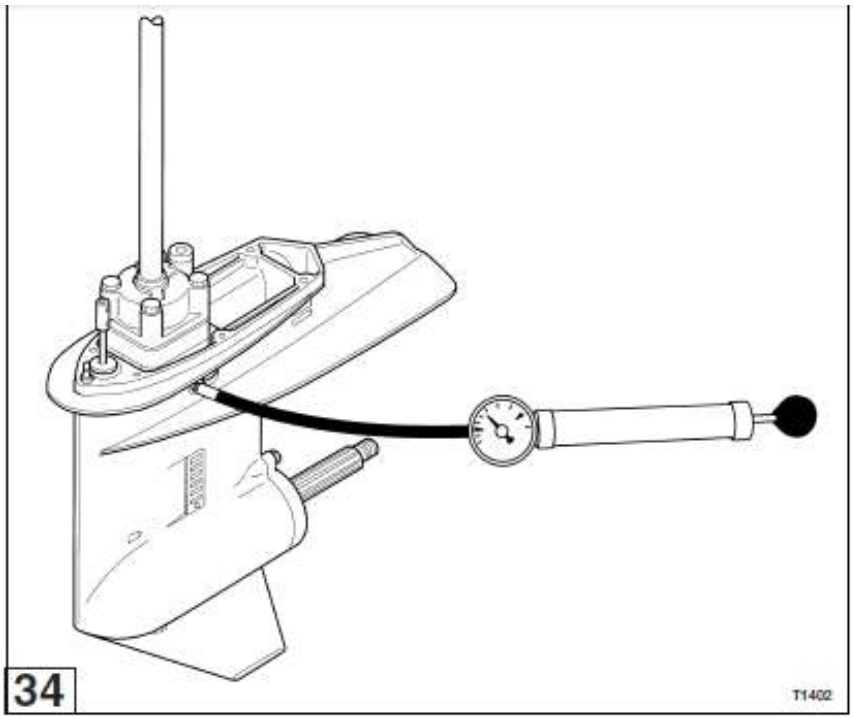
30 T1398



31 T2046







32 19. Align the clutch push rod with the clutch cam and slide the propeller shaft and housing into the gearcase opening. Push forward and rotate the propeller shaft as needed until bevel gears have engaged. Ensure the propeller shaft housing bolts are completely clean and apply Loctite 242 to the bolt threads. Install and torque the bolts evenly to prevent improper seating of the housing.

33 20. Move the cam rod to each position and rotate the driveshaft to test gearcase function in all gears. Check the propeller shaft for looseness in the forward and reverse directions. If looseness exceeds 0.016 in [0.40 mm], replace bevel gear C washer **(26)** with one of correct thickness.

NOTE

Refer to current Parts Catalog for washer availability

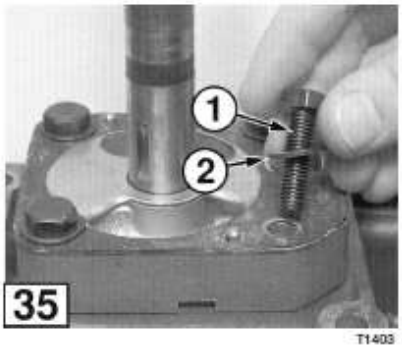
34 21. Before adding gear oil, pressure test and vacuum test the gearcase as follows:

- Remove the oil level plug and install gearcase pressure tester.
- Pump pressure tester until gauge indicates 3 - 6 psi [20 - 39 kPa / 0.2 - 0.4 kg/cm²]. If pressure loss occurs, determine source of leakage by submerging gearcase in water. Make necessary repairs to correct the problem and retest.
- Remove the pressure tester and install gearcase vacuum tester.

- pump vacuum tester until gauge indicates 3 - 5 in [76 - 127mm] of mercury. If loss of vacuum occurs at either range, apply oil around suspected seal. If leak stops or oil is drawn in, the seal is defective and must be replaced. Make necessary repairs to correct the problem and retest.

22. Fill gearcase with specified gear lubricant. See Engine Specifications in Section 2 for gearcase capacities.

23. Apply genuine grease or equivalent to the propeller shaft and propeller mounting hardware. Install the propeller and propeller mounting hardware.



⚠ CAUTION

Make sure propeller thrust holder is installed and seated against the propeller shaft oil seal before installing propeller. If installed improperly, propeller may be pushed into gearcase housing during tightening.

Adjustments

⚠ CAUTION

DO NOT attempt gearcase adjustments without proper manufacturer special tools and adequate knowledge of gearcase setup.

NOTE

Specific assembly steps must be completed in order to perform the gearcase adjustments. If these steps have not been performed, refer to Assembly, this section.

NOTE

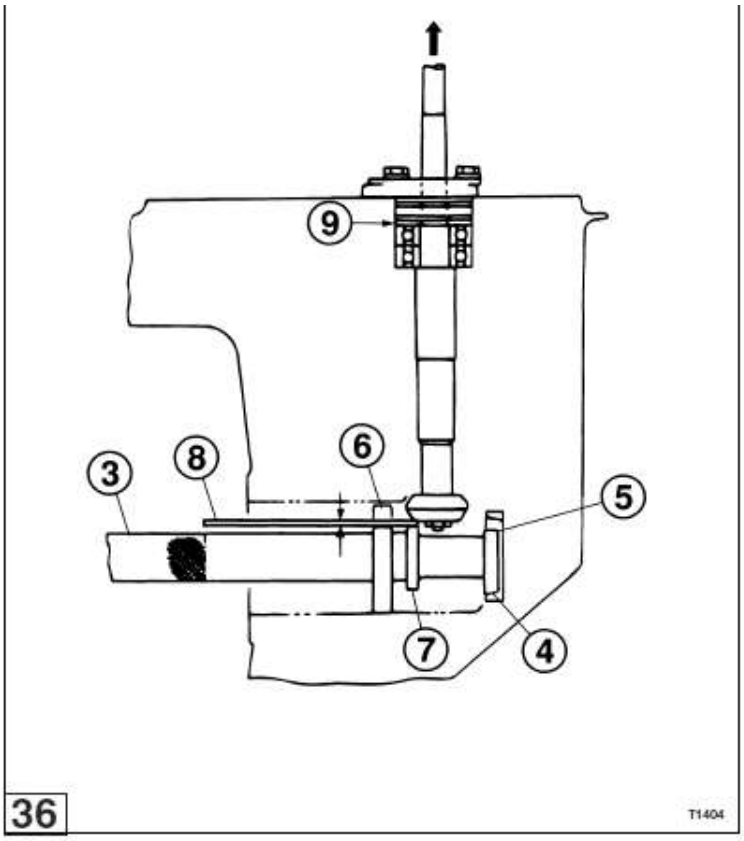
Unless otherwise indicated, all gearcase adjustment specifications are based on measurements obtained with manufacturer special tools.

35 1. Slide lower pump case onto driveshaft and seat into position on gearcase. Secure lower pump case with bolts **(1)** and plain washers **(2)**.

36 2. Insert shimming gauge (3) into gearcase (40 gauge: 3C8-72250-0).

NOTE

Correct positioning of the shimming gauge in the gearcase is critical, Make sure tapered side (4) is fully seated I'n bevel gearA bearing outer race with ilat side (5) and notch (6) facing upward.



36 3. Eliminate all looseness between driveshaft and gearcase using one of the following methods:

- Lift driveshaft upward and tap down on gearcase with rubber mallet.
- Slide acompression spring (obtain locally) over driveshaft and seat onto lower pump case. Install backlash measuring tool clamp assembly (Part No. 3B7-72720-0) on driveshaft. Compress the spring and tighten the clamp to maintain the spring compression and provide constant upward pressure against driveshaft.

With all looseness eliminated, measure the gap between collar **(7)** and bevel gear B using thickness gauge set **(8)** (Part No. 353-72251-0). If gap measurement is not within 0.023 - 0.025 in [0.60 - 0.64 mm], remove the lower pump case and install correct size shim onto roller bearing outer race at location **(9)**.

NOTE

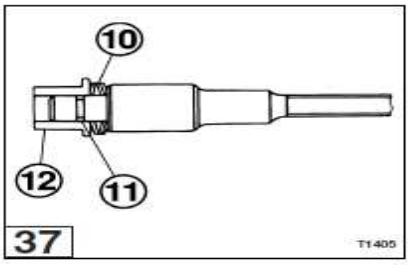
Refer to current Parts Catalog for shim availability.

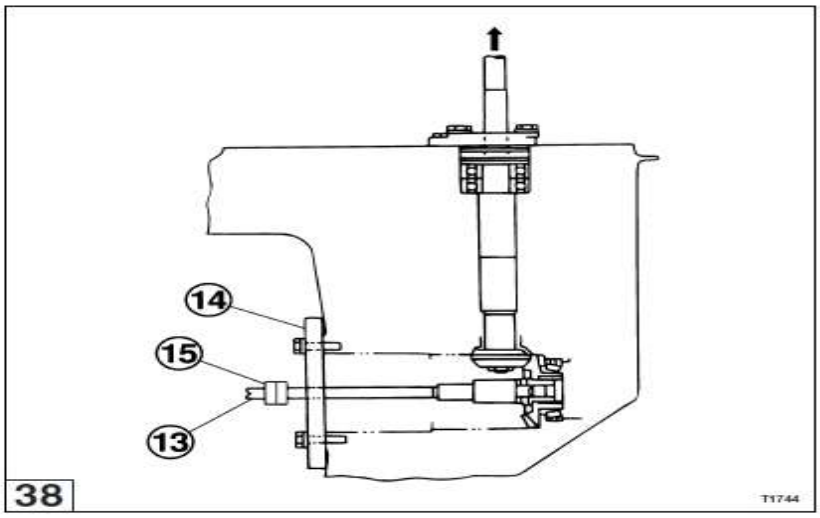
4. If shimming was necessary re-install the lower pump case before proceeding with Backlash Adjustment - Bevel Gears A and B.

Backlash Adjustment - Bevel Gears A and B

Backlash

Special tools are required for measuring backlash. The following describes how to measure and correct backlash in the Raider 40 outboard.





5. With the tapered roller bearing installed, position bevel gear A in gearcase so bearing is fully seated in outer bearing race. Rotate the driveshaft to ensure gears are property meshed.

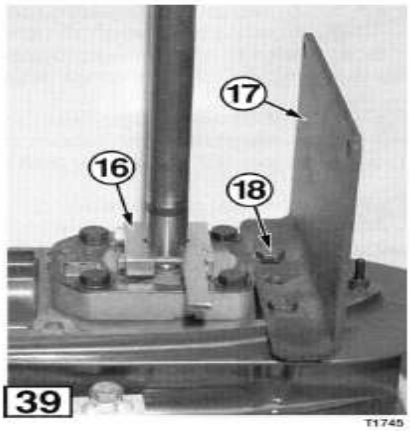
6. Assemble the following backlash tool components. Note the correct quantity and orientation of conedisk spring washers:

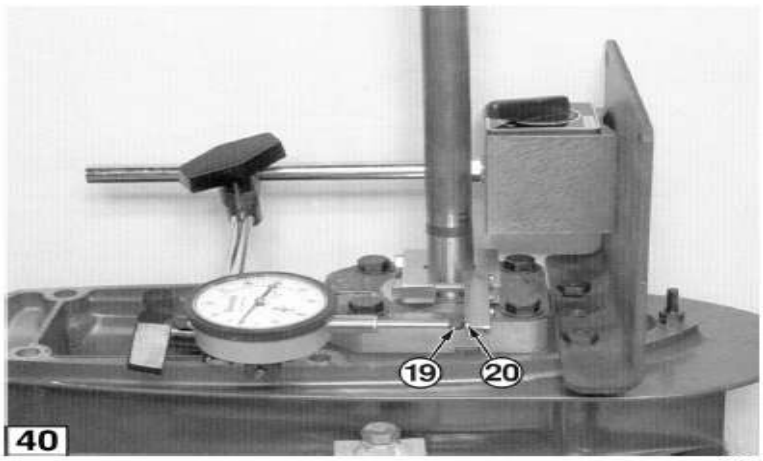
37 Assemble three conedisk spring washers **(10)**, o-ring **(11)**, and collar **(12)**.

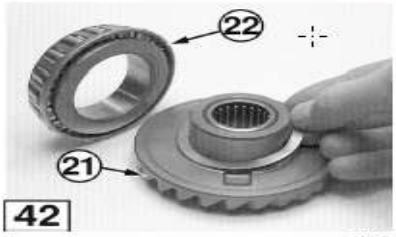
38 7. Insert shaft **(13)** into gearcase and seat collar/guide end in bevel gear A. Install plate **(14)** using appropriate size bolts. Turn shaft nuts **(15)** onto shaft. Tighten the nuts against each other so outer nut can be used to tighten shaft **(13)**.

8. Look the nuts **(15)**.

39 9. Mount clamp assembly **(16)** on driveshaft as close as possible to lower pump case. Install dial gauge plate **(17)** on gearcase with appropriate size bolts **(18)**.





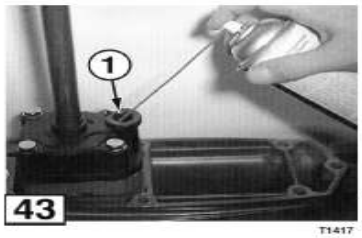


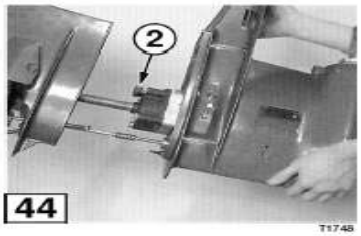
40 10. Mount a magnetic base and dial gauge (obtain locally) as shown. Lift driveshaft upward and tap down on gearcase with rubber mallet to eliminate all looseness and proceed to adjust the setup so dial gauge **(19)** is aligned with V-notch **(20)**.

41 11. Set dial gauge to zero. Lift driveshaft upward and rotate driveshaft in both directions and record the dial gauge reading.

42 If the dial gauge reading is not within the specified range, adjust shim thickness between bevel gear A **(21)** and tapered roller bearing **(22)** in accordance with the Backlash - Shim Adjustment Table, this section. See Gearcase Repair Procedures in this section for removal and installation of the bevel gearA roller bearing.

Model	Acceptable Dial Gauge Reading	
	in	mm
Raider 40	0.0236 – 0.0394	0.60 – 1.00





Installation

⚠ WARNING

Ignition system must be disabled to prevent accidental engine start-up during installation of the gearcase.

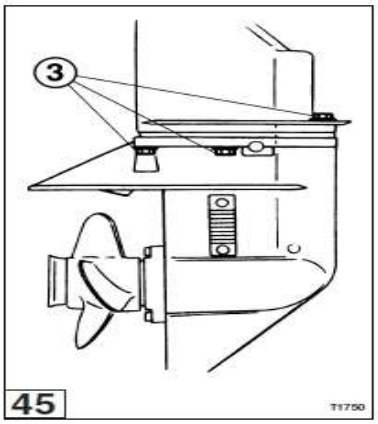
43 1. Lightly coat the driveshaft splines with genuine engine oil or TC-W3 oil and apply silicone spray lubricant to water pipe lower seal **(1)**.

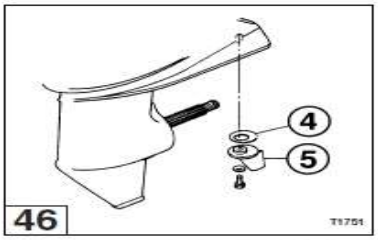
44 2. Slide driveshaft into lower crankcase head. Align water pipe with lower seal **(2)** before seating gearcase on driveshaft housing.

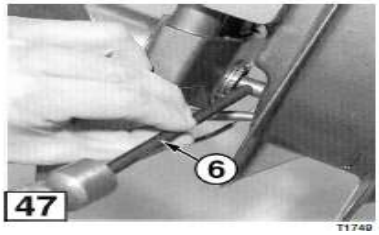
45 3. Apply Loctite 242 to threaded portion of gearcase mounting bolts. Install the gearcase mounting bolts **(3)** and torque all bolts to specification.

46 4. Inspect trim tab **(5)** and replace if corroded. Install trim tab packing **(4)** and trim tab **(5)**.

47 5. Use spring pin tool B **(6)** (Part No. 345-72228-0) to install new upper spring pin in shift rod joint. DO NOT reuse the old spring pin.







Dial Gauge Setting		Shim Thickness + Increase shim thickness – Decrease shim thickness	
40			
in	mm	in	mm
0 - 0.002	0.00 - 0.05	-0.0098	-0.25
0.002 - 0.006	0.06 - 0.15	-0.0079	-0.20
0.006 - 0.014	0.16 - 0.35	-0.0059	-0.15
0.014 - 0.018	0.36 - 0.45	-0.0039	-0.10
0.018 - 0.023	0.46 - 0.59	-0.002	-0.05
0.024 - 0.039	0.60 - 1.00	0	0.00
0.04 – 0.041	1.01 - 1.05	+0.002	+0.05
0.042 - 0.045	1.06 - 1.14	+0.0039	+0.10
0.045 - 0.047	1.15 - 1.20	+0.0059	+0.15
0.048 - 0.053	1.21 - 1.35	+0.0079	+0.20
0.054 - 0.059	1.36 - 1.50	+0.0098	+0.25
0.059 - 0.065	1.51 - 1.65	+0.0118	+0.30
0.065 - 0.071	1.66 - 1.80	+0.0138	+0.35
0.071 - 0.077	1.81 - 1.95	+0.0157	+0.40
0.077 - 0.083	1.96 - 2.10	+0.0177	+0.45
0.083 - 0.089	2.11 - 2.25	+0.0197	+0.50
		+0.0217	+0.55
		+0.0236	+0.60

GEARCASE REPAIR PROCEDURES

⚠ CAUTION

DO NOT attempt gearcase repairs without proper manufacturer special tools.

Use this section when service work requires disassembly or replacement of the following gearcase components:

- Driveshaft roller bearings.
- Gearcase needle bearing.
- Propeller shaft housing needle bearing.
- Bevel gear A bearing outer race.
- Bevel gear A roller bearing.

1

Driveshaft Roller Bearings

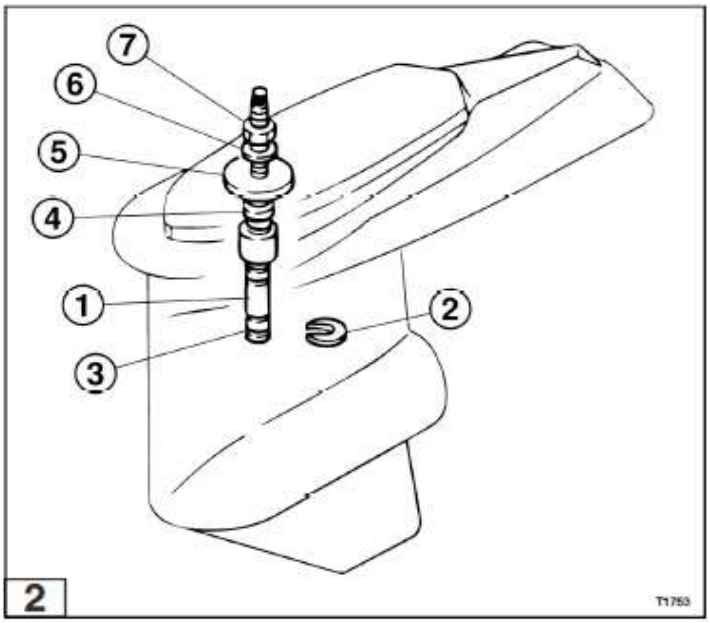
1

⚠ CAUTION

If it is determined after complete inspection that replacement of driveshaft roller bearing (1) is necessary, all pressing operations during removal and installation must be performed at a qualified machine shop equipped with minimum 1 ton Press.

Gearcase Needle Bearing:

Note: Obtain needle roller bearing puller kit: P/N: 3C8-72700-0.



2

Removal

2 1. Insert shaft **(1)** through needle bearing from water pump side of gearcase.

2 2. Attach retainer **(2)** from propeller shaft side of gearcase to shaft groove **(3)**. Make sure retainer is fully seated in groove with raised surface facing bearing:

2 3. Slide guide **(4)** onto shaft from water pump side of gearcase. Make sure guide is seated in bearing.

4. Install plate/flange **(5)**, washer **(6)**, and nut **(7)** onto shaft.

5. Hold end of threaded shaft with wrench and tighten nut **(7)** until bearing releases from housing.

Installation

3 1. Insert shaft **(1)** through needle bearing housing in gearcase.

3 2. Coat the new needle bearing with genuine gear oil. Slide bearing onto shaft from propeller shaft side of gearcase so bearing stamped surface **(2)** faces propeller shaft side.

⚠ CAUTION

Stamped surface of needle bearing must face propeller shaft side of gearcase or bearing could be damaged during installation.

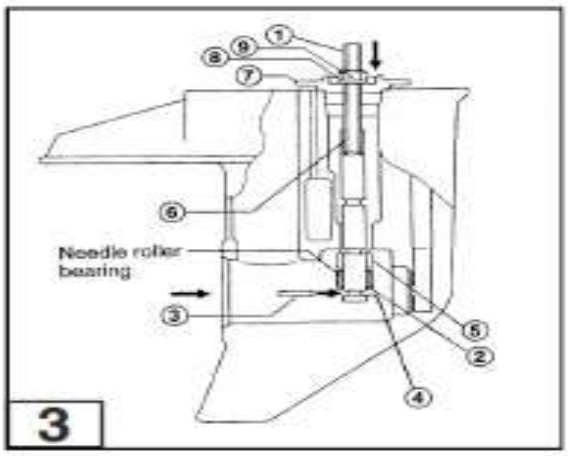
3 3. Attach retainer **(3)** from propeller shaft side of gearcase to specified shaft groove **(4)**. Make sure retainer is fully seated in groove with raised surface facing bearing.

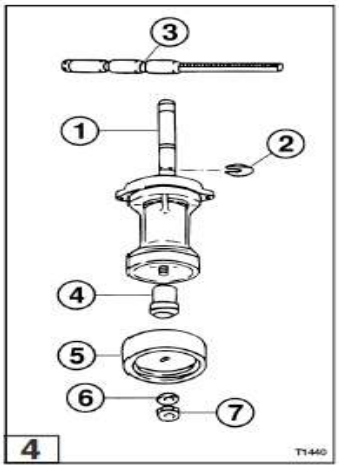
3 4. Slide guide **(5)** onto shaft from water pump side of gearcase. Make sure guide is seated in bearing.

3 5. Install stopper **(6)**, plate/flange **(7)**, washer **(8)**, and nut **(9)** onto shaft from water pump side of gearcase.

3 6. Hold end of threaded shaft with wrench and tighten nut **(9)** until stopper **(6)** contacts plate/flange **(7)**.

7. Remove tools and verify needle bearing is fully seated in housing.





Propeller Shaft Needle Bearing

4 **Removal**

1. Remove oil seal from propeller shaft housing.

2. Remove roller bearing from propeller shaft housing by heating the housing with hot water.

3. Place shaft **(1)** through needle bearing.

4. Attach retainer A **(2)** to shaft groove **(3)** with raised surface of retainer facing bearing.

5. Slide guide B **(4)** and flange B **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

6. Tighten nut **(7)** until needle bearing releases from housing.

5 **Installation**

1. Attach retainer A **(2)** to shaft groove **(3)** with raised surface of retainer facing bearhg.

2. Coat new needle bearing with gear oll. Slide bearing onto shaft so bearing stamped surface faces retainer A **(2)**.

⚠ CAUTION

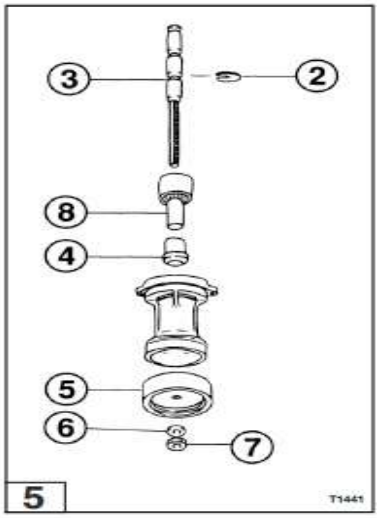
Stamped surface of needle bearing must face retainer or bearing could be damaged during installation.

3. Slide stopper B **(8)** and guide B **(4)** onto shaft and insert shaft in propeller shaft housing.

4. Slide flange B **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

5. Tighten nut **(7)** until stopper B **(8)** contacts flange B **(5)**.

6. Remove tools and verify needle bearing is fully seated in housing.

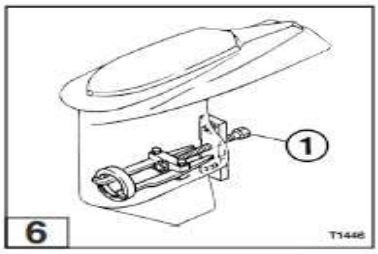


Bevel Gear A Bearing Outer Race

Removal

1. Install bevel gear A bearing puller assembly (Part No. 3A3-72755-0).

6 2. Tighten bolt (1) until bearing race releases from housing.



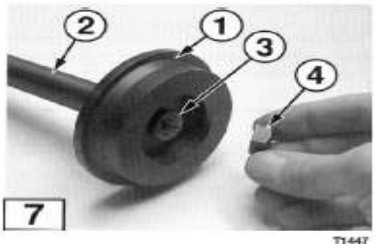
Installation

1. Secure gearcase horizontally in padded vice or other fixture so propeller shaft opening faces upward.

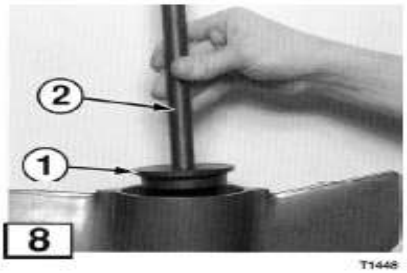
2. Verify bearing race seating surface in gearcase is clean and smooth.

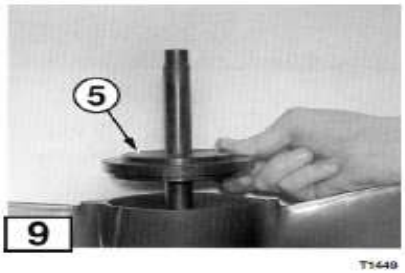
3. Apply specified gear oil to exterior of bearing race. Position race in gearcase so stamped surface faces closed end of gearcase.

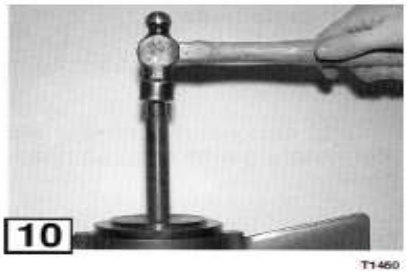
7 4. Attach plate **(1)** to threaded end of rod **(2)** using spring washer **(3)** and nut **(4)**. Tighten nut with wrench.



Tool	Part Number	Model
Bearing Outer Press Kit	3B7-72739-0	'40



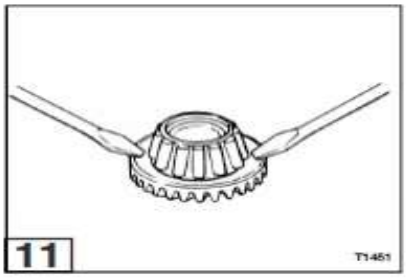




8 5. Insert rod **(2)** into gearcase so plate **(1)** is seated within the bearing race.

9 6. Slide guide **(5)** onto rod and seat into position on gearcase. Raised surface of guide must fit tightly within the circumference of the gearcase opening.

10 7. Fully seat bearing race in gearcase by hammering the rod end.

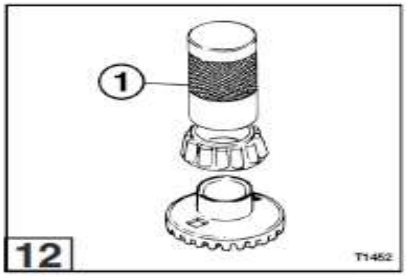


Bevel Gear A Roller Bearing

Removal and Installation

11 1. Insert screwdrivers in notches of bevel gear A and gently pry gear and bearing apart.

12 2. Use specified set tool **(1)** to press fit bearing onto bevel gear.



Tool	Part Number	Model
Set Tool, Bevel Gear A Bearing	3C8-72719-0	40

SECTION 7 – ELECTRICAL SYSTEM

General Precautions

Before performing any service work on the electrical system, read and understand the Service Safety section at the beginning of this manual.

Use the manufacturer and special tools as indicated during servicing of the electrical system.

Avoid electrical shock:

- Do not handle spark gap tester leads during performance testing.
- Do not touch ignition coils, exciter coil, pulser coils, or alternator coils while the engine is cranking or running.

Use the spark gap tester to prevent the engine from starting when performing static ignition performance tests.

Use caution when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

After repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions.

Replace locking fasteners when their locking feature becomes weak.
Use only factory replacement parts.

Always inspect and test the start-in-gear prevention system before returning engine to customer.

SERVICE SPECIFICATIONS

Special Torque Values

Description	Torque in-lb (ft-lb) N-m kg-m	Threadlocker
	40	
Spark Plug	(19 - 21) 25 - 29 2.6 - 3.0	—
Flywheel Nut	(87 - 101) 118 - 137 12 - 14	—

NOTE

Verify direction of flywheel nut rotation. Most are right-hand threads, however, some will have left-hand threads (past production models 9.9/15/18 and 40).

*Refer to Section 2 for Standard Torque Values chart.

Manufacturer Special Tools Required

None

General Precautions

Before performing any service work on the Raider electrical system, read and understand the Service Safety section at the beginning of this Service Manual. Use the manufacturer and special tools as indicated during servicing of the electrical system.

Avoid electrical shock:

- Do not handle spark gap tester during performance testing.
- Do not tough ignition coils, exciter coil, pulser coils or alternator coils while engine is cranking or running.

Use the spark gap tester to prevent the engine from starting when performing static ignition performance tests.

Use caution when performing tests with the engine cowling removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

After repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions.

Replace locking fasteners when their locking feature becomes weak.

Use only COTS factory parts (Mercury, Nissan or Tohatsu) or Raider replacement parts.

Always inspect and test the start-in-gear prevention system before returning engine to mission readiness.

Always disconnect battery when not in use.

General Equipment Required

Analog Multimeter, *Electronic Specialties® Model M-530 or equivalent*
Digital Multimeter, *Electronic Specialties® Model KD 3200 or equivalent*
Spark Gap Tester, *Stevens® S- 13C, S-48, or equivalent*
Digital Pulse Tachometer, 10 - 6000 RPM, *Electronic Specialties® Model 321 or equivalent*
Variable Load High Rate Discharge Tester, *Electronic Specialties® Model 700 or equivalent*
Hydrometer
Heat Gun
Torque Wrench, 0 - 150 in-lb [0 - 17N-m / 0 - 1.7kg-m]

Consumables Required

Dielectric Lubricant, *Permatex® Dielectric Tune-Up Grease*
Battery Spray Protector, *Permatex® Battery Protector and Sealer*
Low Temperature Lithium Grease
Genuine Grease or Equivalent Friction Surface Marine Grease
Threadlocker, *Loctite® 243*
Isopropyl Alcohol
Cleaning Solvent
Thermomelt Stik, 125°F [52°C] and 163°F [73°C]
Electrical Shrink Fit Tubing, various diameters

Electrical System - Overview

Ignition Type: Flywheel Magneto Capacitor Discharge
Ignition Timing: Before Top Dead Center (BTDC) – 25 Degrees ATDC – 2 Degrees
Spark Plug: Pulstar – Model SBE 1/10
Spark Plug Gap: .033 (No larger than .050)
Battery: Part No. 365-265-001 (Raider sealed Lithium Iron – 265 CA)
Alternator: 12V 80W
Charging Performance @ 5500 – 5 Amps
Ignition Coil Resistance – Primary Coil: 0.2 – 0.3 KOhms
Secondary Coil: 4.1 – 6.1 K Ohms
CD Unit Output (Cranking): 198-220 DVA
Exciter Coil Output (Cranking): 100 DVA Mim
Pulser Coil Output (Cranking): 4.75 – 5.0 DVA
Coil Resistance – Exciter Coil: 130-195 Ohms
Alternator W-Y: Y-W 0.65 - 0.98
Y-B 0.31 – 0.47
W-B – 0.37 – 0.55

Electrical Connectors

When you replace electrical components or perform diagnostic tests, you must disconnect electrical connectors in many instances.

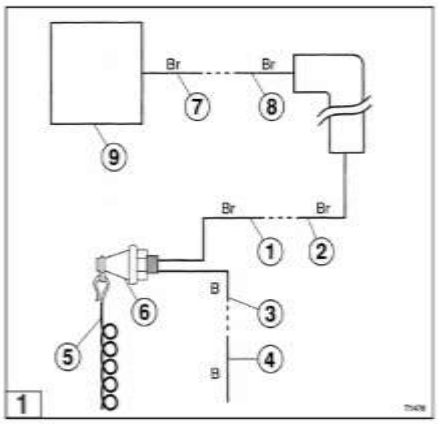
The following discussion will help you recognize connectors in electrical drawings and show you how to disconnect and connect them.

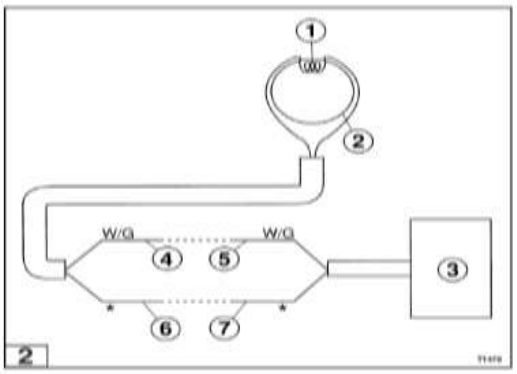
Electrical Connector Drawings

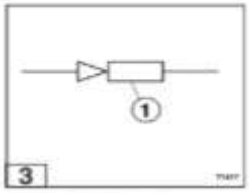
In most of the electrical drawings in this section, the physical shape of electrical connectors has been eliminated to clarify testing procedures.

1 A typical electrical drawing illustrates several connectors. Items **(1)**, **(2)**, **(3)**, **(4)**, **(7)** and **(8)** are terminals that are located inside of electrical connectors. The dashed line between two terminals [e.g., between terminal **(7)** and **(8)**] means that they are a part of the same connector but have been disconnected for testing.

Note that Terminal **(7)** is directly connected to the CD Unit **(9)** (no connectors between the terminal and CD Unit). When you disconnect an electrical connector to test a component, it is very important that you disconnect the FIRST CONNECTOR. Terminals **(1)**, **(3)** and **(7)** are examples of how the first connector is illustrated.







2 Special cases are the connectors used to test components located on the coil plate assembly. For testing purposes, the first connector is located at the far end of the cable (away from the coil plate assembly).

Bullet Connectors

NOTE

3 *Bullet connectors **(1)** are shown like this in electrical drawings.*

Disconnecting Bullet Connectors

1. Carefully examine the connector to determine which end is removable and which end is fixed. Typically the insulation surrounding the removable end is tapered so it fits inside of the insulation for the fixed end.

4 2. Grasp the fixed end **(1)** of the connector and carefully pull the removable end **(2)** straight out without twisting or bending it.

NOTE

Never twist or bend bullet connectors or damage to the connectors will occur. Always PULL these connectors apart.

Electrical Cable Color Codes

Electrical cables have color coded conductors so you can locate the correct conductor during troubleshooting and repair procedures. All conductor colors are in capital letters in this manual.

Some conductors have a background color and a different color stripe that runs the length of the conductor. These conductors are designated as follows:

A/B
Where A = Background Color
B = Stripe Color

Example:
BLACK/WHITE
This conductor has a BLACK background with a WHITE stripe.

Electrical Drawings

All electrical drawings shown in this manual have been simplified to clarify the circuit that is being tested. They represent typical configurations and may not look exactly like the electrical wiring for your engine. Complete electrical schematics are provided in the Outboard Motors Service Data publication.

Troubleshooting - Electrical

The troubleshooting chart lists common engine symptoms related to problems with the electrical system. It also indicates specific malfunctions in the electrical system which may be causing a problem so it can be isolated more effectively. Before beginning major troubleshooting on the electrical system, perform the following operations:

- Check battery fluid level and specific gravity. Charge or replace as required. See Battery Care and Maintenance, this section.
- Check the following electrical connections and make sure they are secure and free of corrosion:
  - Battery cables
  - Starter solenoid wiring
  - Starter motor wiring (including ground connection)
  - Spark plug leads
  - Ignition circuit wiring
  - Stop circuit wiring
  - Charge circuit wiring
- Make sure shift lever or remote control lever operates freely.
- Attach lanyard to emergency stop switch, see Section 2.

Ignition System

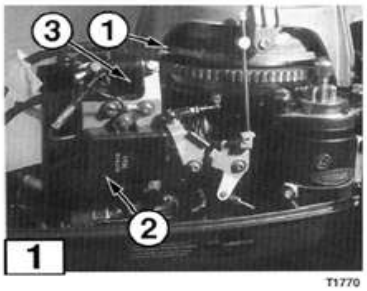
SYMPTOM / CHECKS	Cranks but will not start	Wilt not start and pops or backfi res	Starts but stops immediately	Low or high speed miss	Poor accel-eration, low top end RPM	Engine will not shut off
Faulty stop circuit - see Test 2 - stop Circuit Test, this section						●
Faulty ignition system - see Ignition System Performance Testing, this section		●		●	●	●
Faulty spark plug(s) - See Section 2	●		●	●	●	
Incorrect ignition timing or carburetor synchronization - See Section 2		●	●	●	●	

Starting System

SYMPTOM / CHECKS	Will not crank
Internal battery	●
Faul[illegible]ey switch	●
Not in Neutral, defective Neutral switch	●
Faulty battery, starter solenoid/ starter motor cable	●
Faulty starter solenoid	●
Faulty starter motor: - Faulty brushes - Damaged pinion assembly	●

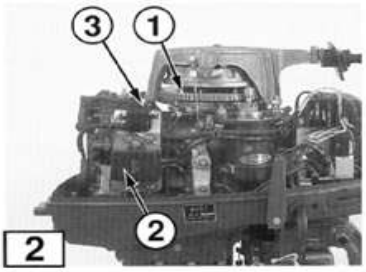
Charging System

SYMPTOM / CHECKS	Battery does not maintain charge / recharges
Wiring/Connector	●
Shorted or faulty alternator coil	●
Faulty recitier/regulator	●
Faulty charge circuit wiring	●



1

T1770

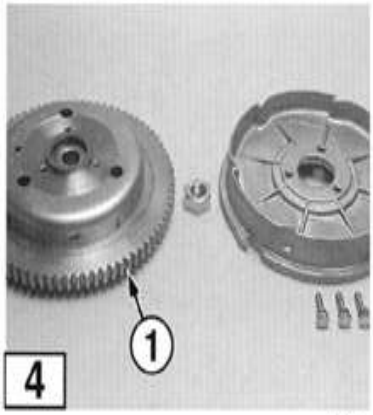


2

DESCRIPTION OF OPERATION

Ignition System

1 2 3 The ignition system consists ofthe magneto **(1)**, Capacitive Discharge (CD) unit **(2)**, ignition coil **(3)**, main key switch **(4)** and emergency stop switch **(5)**. The purpose of this system is to provide an electric spark inside each cylinder at the precise moment needed by the combustion chamber.



4

T1981

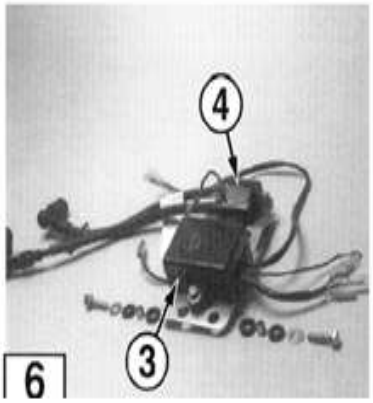
5

T1982

Magneto

4 5 6 7 The electrical system consists of a flywheel **(1)**, coil plate assembly **(2)**, a CD unit **(3)** and an ignition coil **(4)**. The 1/2 cylinder engines are comprised of seven basic electrical systems. The following chart demonstrates not only the differences but the similarities:

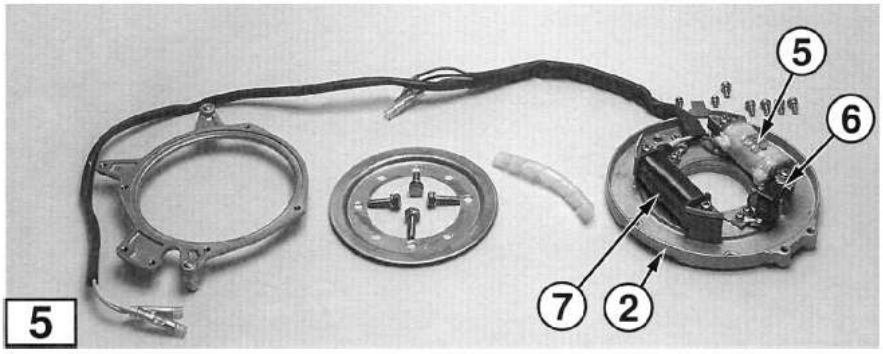
Raider has: (1) CD Unit; (2) Coil Plate; (3) Exciter Coil; (4) Ignition Coil; (5) Pulser Coil; (6) Alternation/Lighting coil.



6

4 Flywheel

Mounted radially inside the flywheel **(1)** are a number of high performance ferrite magnets. As the flywheel rotates, the magnets pass in front of the coils (exciter / alternator) to produce voltage in the coils.



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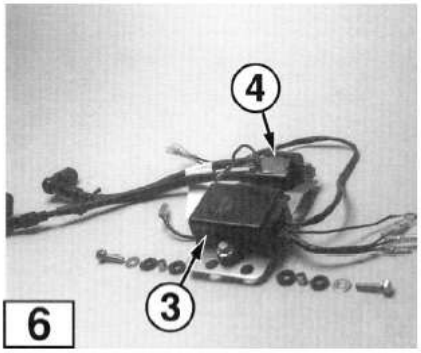
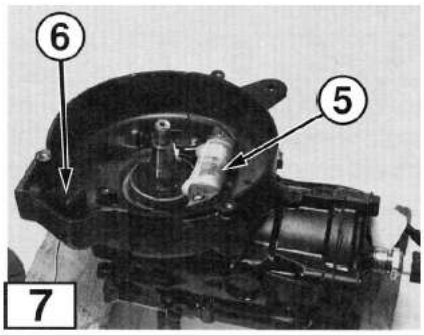


T1983

5 7 Coil Plate

The coil plate is a part to which exciter coil, pulser coil and alternator coil are attache :.) The coil plate is rotated for ignition advance.



T2212

5 7 Exciter Coil

The exciter coil **(5)** consists of many windings of wire wrapped around a metal lamination. Once the flywheel exceeds a minimum cranking RPM, the lines of force from the ferrite magnets contained within the flywheel cut through the exciter coil windings. This will produce about 100 DVA or over(peak voltage) at cranking speed. A minimum of 100 DVA(peak voltage) at cranking speed must be detected. The output of the exciter coil provides power to the CD Unit.

5 7 Pulser Coil

The pulser coil **(6)** consists of an iron core with numerous windings of a wire wrapped around it. The flywheel is equipped with a metallic cam called an interrupter molded into it. When the interrupter passes in close proximity to the pulser coil, the permanent magnet's lines of force collapse momentarily. At cranking speed this produces a 4.75 to 5.0 DVA signal in the coil. A minimum of 3 DVA must be detected during testing.

The output voltage from the pulser coil is used to control a small electronic switch (SCR) located inside the CD Unit. When the CD Unit receives an output from a pulser coil, it directs an output, approximately 220 DVA, to the appropriate ignition coil primary.

5 Alternator/Lighting Coil

The larger 1/2 cylinder engines (9.9-40) are provided with an alternator coil **(7)** mounted on the coil plate which may be used to power a lighting circuit and/or recharging circuit if equipped with this option. An Alternator/Lighting Coil is available as an add-on to the 5 and 8/9.8 models.

6 CD Unit

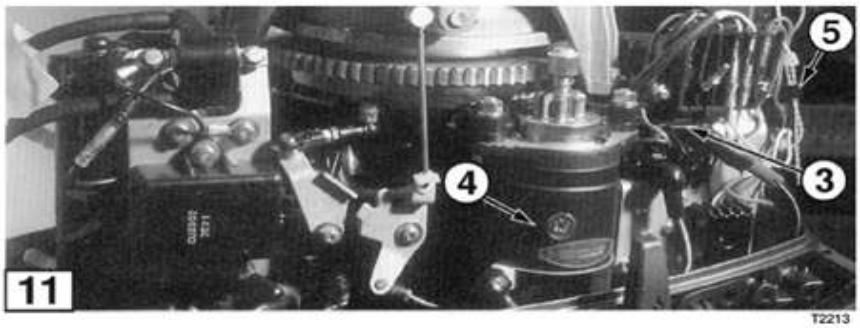
The CD Units incorporate a printed circuit board (PCB) encased in a black resin housing to protect the circuitry from water and vibration. Major components include a diode used to rectify current generated by the exciter coil, a capacitor which charges the voltage supplied, a thyristor which serves as a breaker and a zener diode used to control the thyristor. Additional components such as resistors and SCR's are also provided depending upon the model.

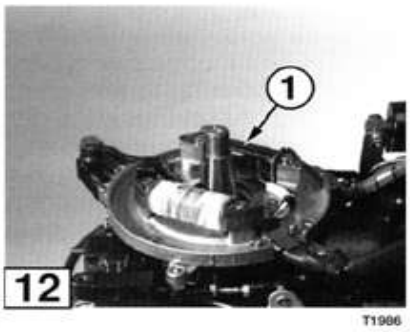
6 Ignition Coil

Each ignition coil **(4)** consists of two windings or wire wrapped around a compacted ferrite material. The coil has a primary and secondary terminal connection and a ground plate. Through mutual induction, the ignition coil transforms the output from the CD Unit to as much as 20,000 - 30,000 volts to fire the spark plug. The ignition coil is generally adjacent to the CD Unit and attached to its mounting bracket, with the exception of the 8/9.8 CD Unit where the ignition coil is molded as together as part of the CD Unit.

Main Key Switch and Emergency Stop Switch

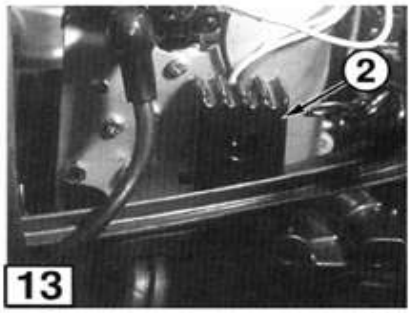
The emergency stop switch is connected to the CD Unit through an engine wiring harness. When lanyard is removed from the emergency stop switch, an input to the CD Unit is grounded. This deactivates the CD Unit and the engine shuts down. If the engine is fitted with the Remote Control feature, pressing the stop switch on the Remote Control Unit will also ground the CD Unit.





Starting System - Optional Electric Start

11 The starting system consists of the battery, main key switch, neutral start switch, starter solenoid **(3)**, starter motor **(4)** and 15 A engine fuse **(5)**. When the main key switch is in the START position, and the start contacts of the neutral start switch are closed, power is sent to the starter solenoid, energizing it. When the starter solenoid is energized, a connection between the positive terminal of the battery and the starter motor is provided. The connection between the starter motor and ground completes the circuit. The fuse opens if the coil circuit of the starter solenoid shorts or overloads.



Charging System

12 **13** The charging system consists of the alternator coil set **(1)**, rectifier **(2)**, 10 or 15 A engine fuse, and the battery. When the flywheel is turning approximately 1500 RPM or higher, the alternator coil set provides alternating current (AC) voltage to the rectifier/regulator. The rectifier transforms the AC voltage into direct current (DC) voltage.

Battery Care and Maintenance

⚠⚠ **WARNING**

The Raider 40 outboard motor has a battery located internal, located under the cowling.
This battery is a fully sealed lithium-iron battery shown below.

The battery has one plug with two connectors (+) and (-). It is constructed that it can be plugged into the mating connector one way.

Battery Size: Length: 5.83 inches x Width 2.63 x Height 4.13 inches
Weight: 2.5 pounds
Cold Cranking Amps: 270
Polarity: (+) (-)
Charging System: Output of 13.1 Volts
Lithium-iron: 18 Ah PbEq 12V; eq, "L" polarity, Sealed
Fastening System: Slot in base of battery receptacle; single screw at top.

General Procedures

Inspection

Inspect battery case for damage
Inspect connector for corrosion
Inspect cables
Check battery mounting

Cleaning

Disconnect and remove battery
Clean battery, connectors
Wash with water and let dry
Place dielectric grease on both side of connector
Replace battery, tighten screw.
Do not plug in connector until ready for use

Ignition System

⚠ CAUTION

All cranking output tests must be performed with spark plugs installed and torqued in the cylinder head. It necessary to remove the spark plugs, be sure to keep the spark gap tester away from open spark plug holes.

⚠ CAUTION

Avoid electrical shock:

- **Do not handle spark gap tester heads during performance testing.**
- **Do not touch ignition coils, exciter coil, pulser coils, or alternator coils while the engine is cranking or running.**

⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

When repairs are complete; make sure all ignition and electrical Leads are properly routed and clamped in their original systems And the in-gear prevention system must be tested prior to delivering to units.

Ignition System Performance Testing

Ignition Performance Testing is divided into two sections. The first section consists of a flow chart. This chart presents the correct sequence of performing ignition system performance tests to effectively and efficiently check for problems in starting and running the engine. Follow the steps in the order listed until the problem is resolved and the ignition system meets specifications while the engine is running.

The chart references specific performance tests that must be completed to resolve each problem. These tests are described in detail in the section which follows the flow chart.

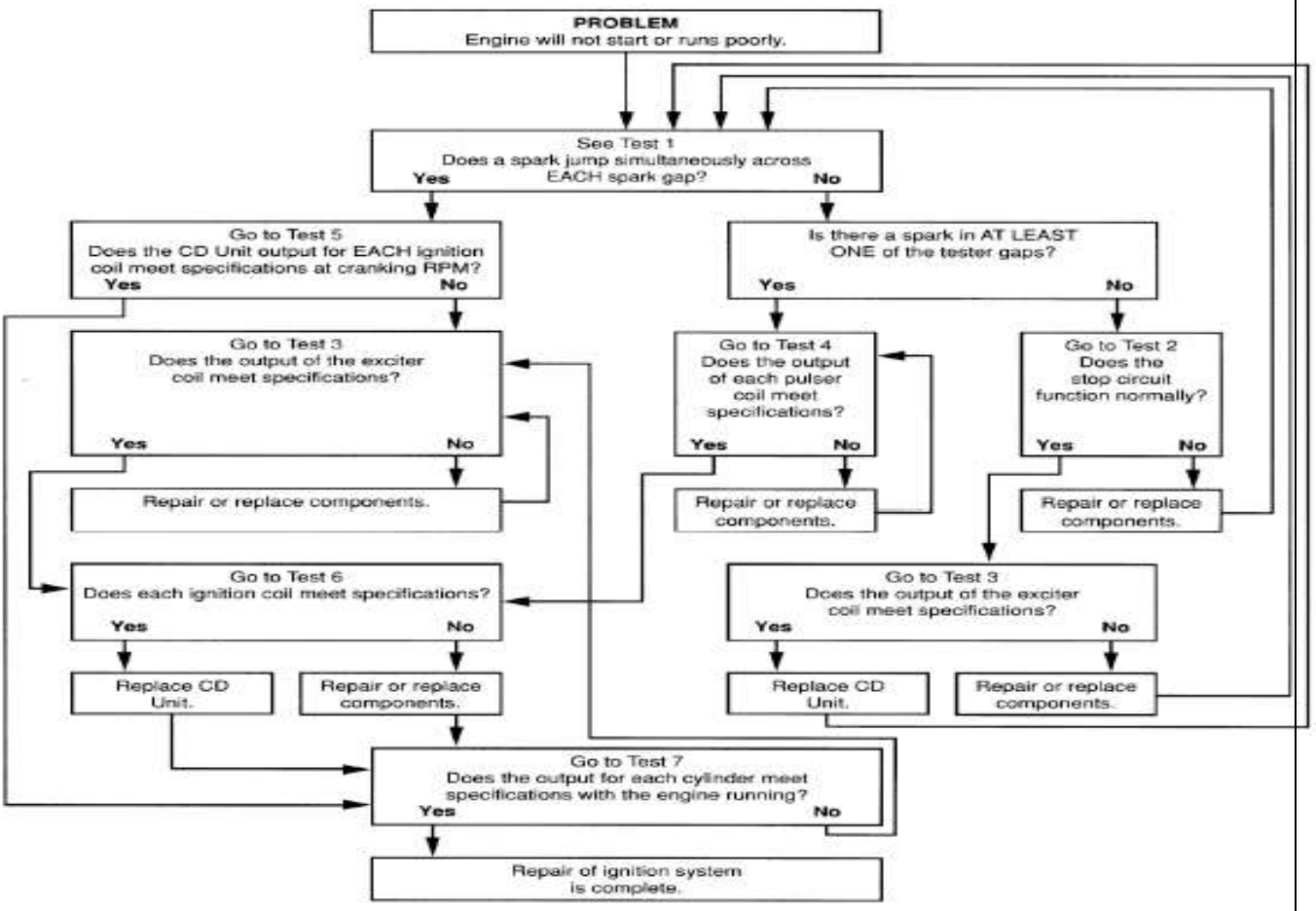
The performance tests, identified as Test 1 through Test 7, contain specific instructions for testing and servicing various ignition system components. Use this section to perform the tests correctly in accordance with the factory recommendations.

NOTE

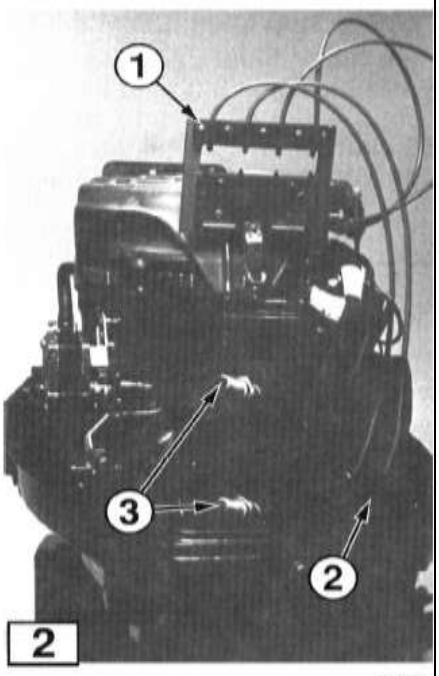
After you complete each performance test refer back to the flow chart for the next step. You must follow the flow chart until the ignition system meets specifications while the engine is running. The only way to be sure that you have uncovered and repaired all ignition system problems is to follow these procedures in a systematic fashion.

If you have problems stopping Raider outboard proceed directly to test 2 – Stop Circuit Test

Ignition System Performance Testing Flow Chart


PROBLEM
Engine will not start or runs poorly.
See Test 1
Does a spark jump simultaneously across EACH spark gap?
Yes
No
Go to Test 5
Does the CD Unit output for EACH ignition coil meet specifications at cranking RPM?
Yes
No
Is there a spark in AT LEAST ONE of the tester gaps?
Yes
No
Go to Test 3
Does the output of the exciter coil meet specifications?
Yes
No
Repair or replace components.
Go to Test 4
Does the output of each pulser coil meet specifications?
Yes
No
Repair or replace components.
Go to Test 2
Does the stop circuit function normally?
Yes
No
Repair or replace components.
Go to Test 6
Does each ignition coil meet specifications?
Yes
No
Replace CD Unit.
Repair or replace components.
Go to Test 3
Does the output of the exciter coil meet specifications?
Yes
No
Replace CD Unit.
Repair or replace components.
Go to Test 7
Does the output for each cylinder meet specifications with the engine running?
Yes
No
Repair of ignition system is complete.

Test 1 - Spark Test



NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

1. Remove all spark plug leads, and spark plugs **(3)**.

2 2. Adjust spark gap tester **(1)** to 7/16 in [11 mm].

3. Connect each spark plug lead to spark gap tester **(2)**.

4. Secure spark gap tester to a clean ground on engine block.

⚠⚠ WARNING

To avoid possible shock hazard, do not handle ignition coils or spark gap tester during cranking tests.

NOTE

To prevent possible arcing of high voltage, route tester leads at least 2 in [51 mm] from any metal surface.

Ground unused test leads to a clean engine ground.

5. Attach lanyard to emergency stop switch,

6. Crank engine.

A spark should jump across the gap for each cylinder and alternate from one gap to another.

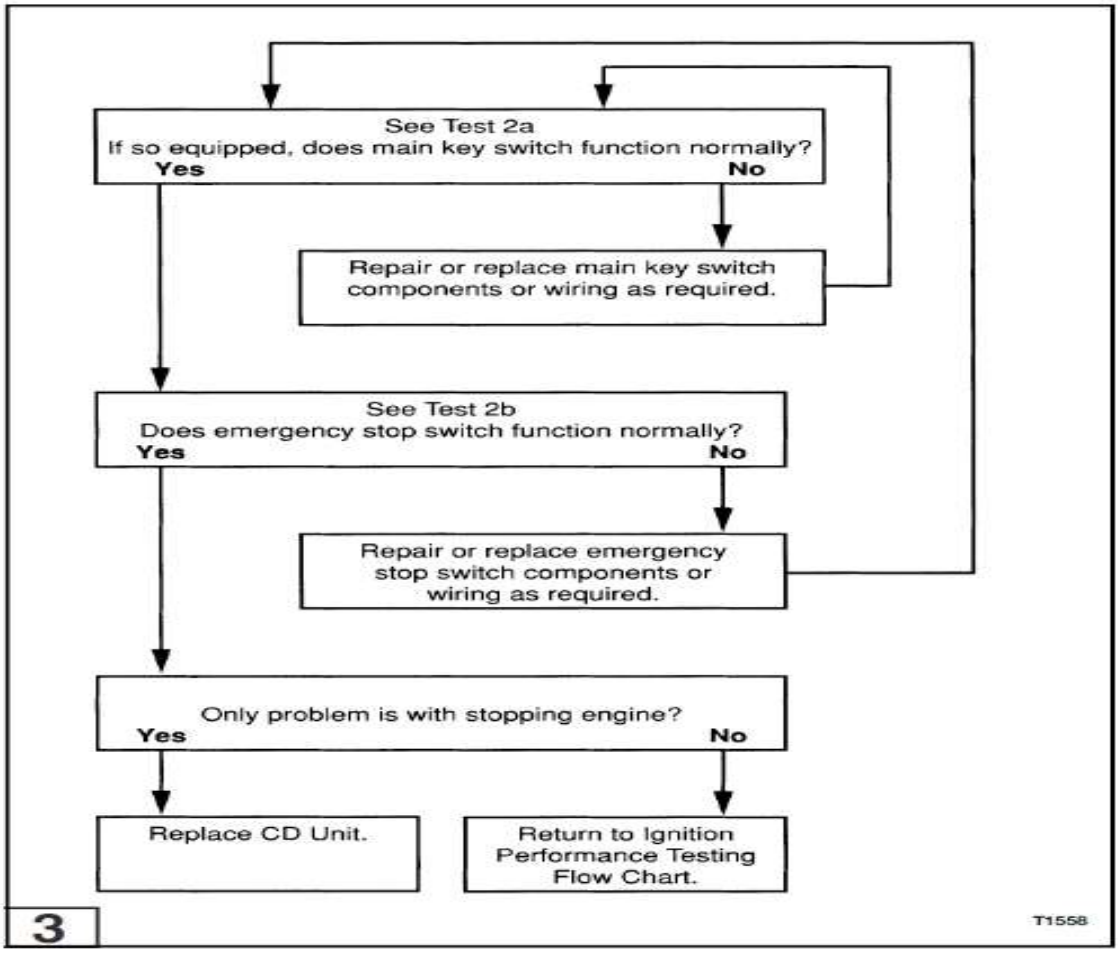
7. Reconnect all wires disconnected during test.

8. Return to Ignition System Performance Testing Flow Chart.

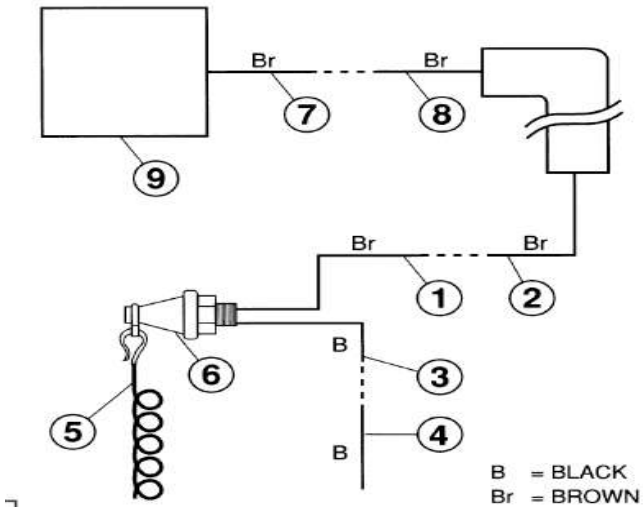
Test 2 – Stop Circuit Test

Stop circuit malfunction can cause Raider not to start or preventing it from stopping. Several component failures can cause the stop circuit to malfunction. Use this flow Chart to isolate and repair all component failures.

Note: After you complete each stop circuit test, refer back to this flow chart for the Next step.



Test 2b. Stop Circuit Emergency Stop Switch Test



The emergency stop switch test is used to determine whether it is functioning normally.

Note: Make sure all electrical terminals are connected during this test except those that are noted in the test procedure. Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure. All continuity tests must be conducted or you may damage the meter.

Remove plug from Raider battery.

6 2. Disconnect emergency stop switch terminals **(1)**, **(2)**, **(3)** and **(4)**.

6 3. Set analog multimeter to check continuity. Connect one meter lead to terminal **(1)** and the other to terminal **(3)**.

6 4. Attach lanyard **(5)** to emergency stop switch **(6)**, meter must not show continuity. If it does, replace emergency stop switch.

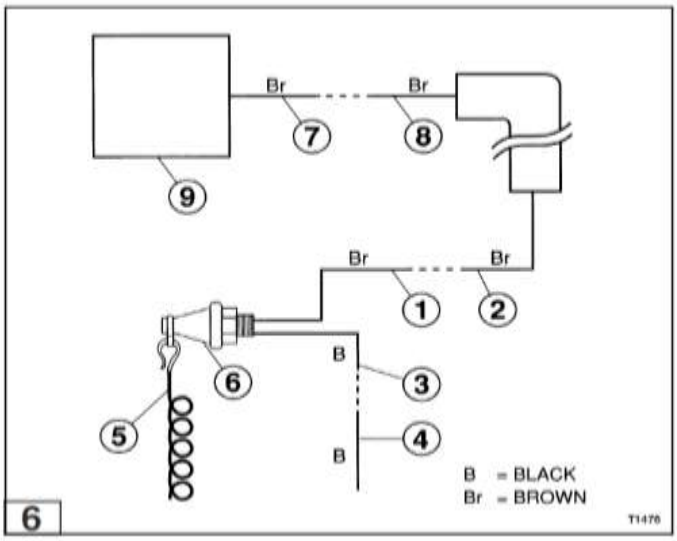
6 5. Remove lanyard **(5)** from emergency stop switch **(6)**, meter must show continuity. If not, replace emergency stop switch.

6 6. Disconnect CD Unit **(9)** terminals **(7)** and **(8)**.

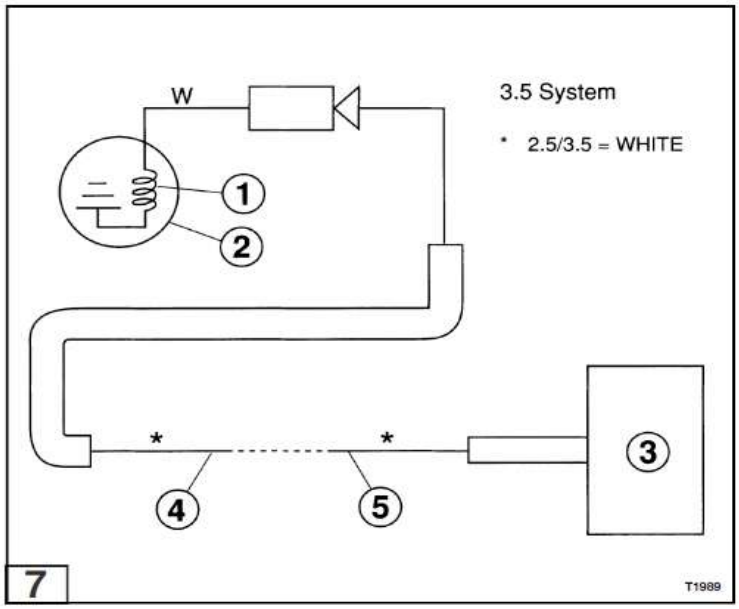
6 7. Connect one meter lead to terminal **(8)** and the other to terminal **(2)** and check continuity. If the meter does not show continuity, replace the cable.

6 8. Connect one meter lead to terminal **(8)** and the other to a clean engine ground. If the meter shows continuity, replace the cable.

9. Reconnect all wires and return to -Test 2 - Stop Circuit Test flow chart.



Test 3 – Exciter Coil Test



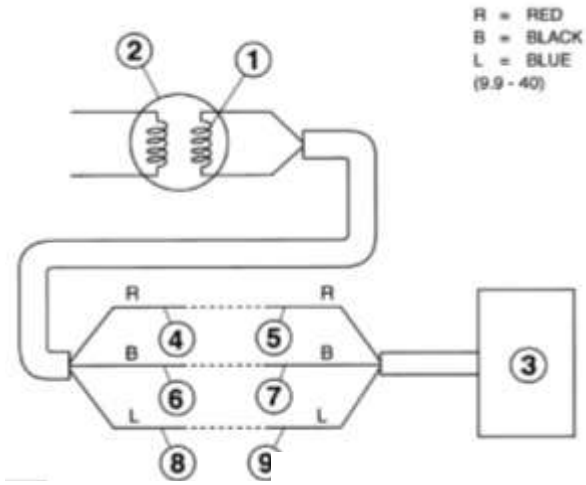
NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and he ground connection for the magneto place, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the exciter coil test. The pulser and alternator coils have been removed from both illustrations for clarity.

Test 3 – Exciter Coil Test



The exciter coil test is used to determine the output voltage, in DVA, from the exciter coil
Located on the coil plate assembly (2) to the CD Unit while you are cranking the engine.

Disconnect terminals 4, 5, 8 and 9.

Set the digital multimeter to ohms and connect the leads between the following Terminals to read the resistance of the exciter coil:
Connect multimeter between 4 and 8 terminals.
The meter should read 200 – 300 ohms +/- 25%
If the resistance is not within the indicated range, replace the exciter coil set. See Ignition System Repair Procedures – Exciter Coil. After repairs are made, return to Ignition System Performance Flow Chart. If the resistance is within indicated range, proceed to the next step.
Connect multimeter between these terminals 4 and 8; set the analog multimeter to "400" on the "DVA" scale. Connect the RED tester lead to terminal "4" and BLACK tester lead to termanal "8".
Attach lanyard to emergency stop switch.
Crank Raider outboard engine.
At cranking RPM, the tester should show the following results: 100 DVA Minimum.
If the exciter coil test results are not within the acceptable range, replace the exciter coil set. See Ignition System Repair Procedures Exciter Coil.

Reconnect all wires disconnected during test.

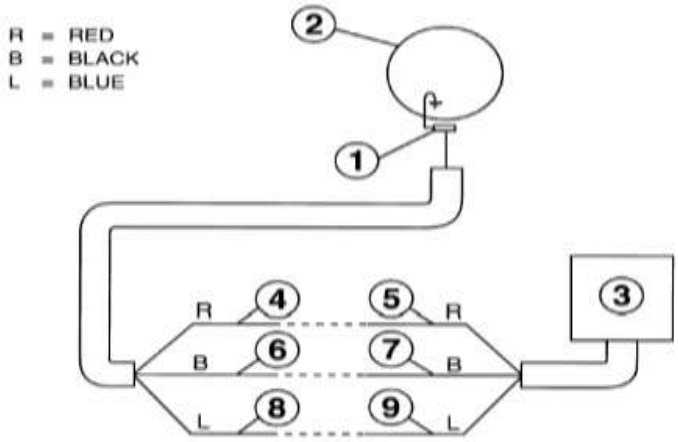
Return to flow chart.

Test 4. Raider Pulser Coil Test

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

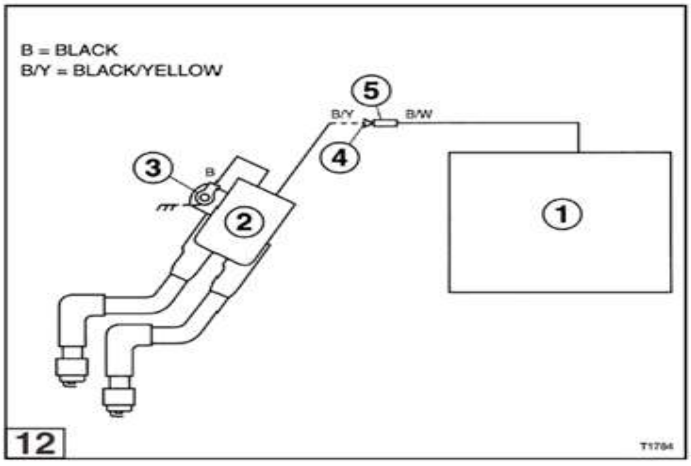


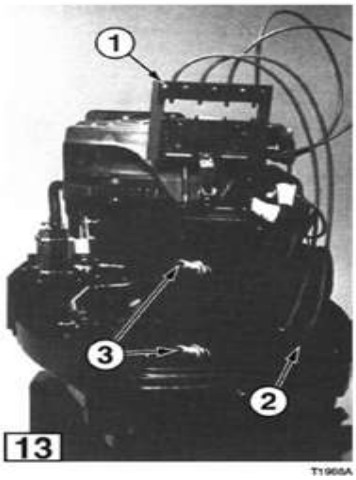
The Raider pulser coil test is used to determine the output voltage, in DVA, from the pulser coil (1) located on the coil plate assembly (2) to the CD unit (3) while you are cranking the engine.

Disconnect the following terminals: 4, 5, 6, 7, 8 and 9
Set the digital multimeter to ohms and connect the leads to test the resistance of the coil.
Connect multimeter between 6 and 8 terminals.
Multimeter should indicate 30 – 45 ohms +/- 25%
If the resistance is not within the indicated range, replace the Raider pulser coil. See Ignition System Repair Procedures – Pulser Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.
If the resistance is within the indicated range, proceed to the next step.
Set the analog multimeter to “20” on the “DVA” scale.
Insert the banana plug of the RED tester lead into the meter connection labeled “DVA” and the banana plug of the BLACK tester lead into the meter connection labeled “COM.”
Black lead to Terminal 6 and Red Lead to Terminal 8.
Attached lanyard to emergency stop switch.
Crank engine.
At the cranking RPM; the tester should show the following results – minimum of 3.0 DVA
If the pulser coil test results are not within the acceptable range, replace the pulser coil

set. See Ignition System Repair Procedures – Pulser Coil.
Reconnect all wires disconnected during test.

Test 5. CD Unit Output test – Cranking RPM





NOTE

Make sure all electrical terminals on Raider are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, DC Unit and Ignition Coil before conducting the following procedure.

Reference the electrical drawings for the CDE Unit Output Test – Cranking RPM.

[12] The CD Unit Output Test – Cranking RPM is used to determine the output voltage, in DVA, from the CD Unit (1) to the ignition coil (2) while you are cranking the engine.

1. Remove two spark plug leads and remove spark plugs (3)

[13] 2. Adjust spark gap tester (1) to 7/16 inches - 11 mm

3. Connect each spark plug lead to spark gap tester (2)
4. Secure spark gap tester to a clean ground on engine block.
5. Secure spark plug gap tester to a clean ground on engine block.

⚠⚠ **WARNING**

To avoid possible shock hazard, do not handle
Ignition coils or spark gap tester during cranking tests.

NOTE
To prevent possible arcing of high voltage, route tester leads
At least 2 inches from any metal surface.

Ground unused test leads to a clean engine ground.

5. Set the tested to “400” on the “DVA” scale.

Insert the banana plug of the RED tester head into the meter connection labeled “DVA” and the banana plus of the BLACK tester lead into the meter connection labeled “-COM.”
Connect the BLACK tester lead to terminal (3).

[12] 8. Carefully slide the RED tester into the bullet connector (terminal 4) sleeve until it makes contact with the terminal.

NOTE

DO NOT disconnect the CD Unit output connector
(terminals (4) and (8). Damage to the CD Unit may result.

9. Attach lanyard to emergency stop switch.

10. Crank engine

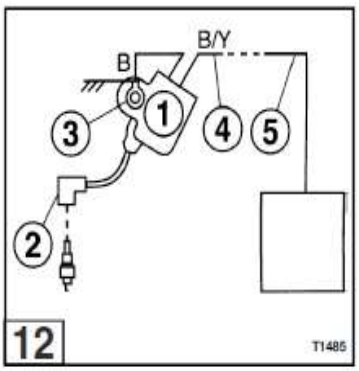
At cranking RPM, the tester should show the following result for each CD Unit output – 100 DVA minimum.

If the test results for any CD Unit output is not within acceptable range, replace the CED Unit. See Ignition System Repair Procedures – CD Unit.

Reconnect all wires disconnected during test.

Return to flow chart.

Test 6 - Ignition Coil Tests



NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

14 The following tests check the resistance of the primary and secondary windings in each ignition coil **(1)**.

1. Remove spark plug lead **(2)**.

2. Set digital multimeter to ohms.

3. Disconnect terminals **(4)** and **(5)**.

4. Connect one tester lead to terminal **(3)** and the other terminal **(4)**.

5. The meter should indicate the following readings for the primary winding.

Repeat readings for each ignition coil: 0.2 – 0.3 ohms +/- 25%

6. If primary winding for any ignition coil is not within the acceptable range, replace the ignition coil. See Ignition System Repair Procedures - Ignition Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.

If the primary windings are within the acceptable range, proceed to the next step.

7. Connect one tester lead to terminal **(3)** and the other to spark plug lead (cap) [terminal **(2)**].

8. The meter should indicate the following readings for the secondary winding.

4.1 – 6.1 kohms +/- 25%

9. If secondary winding for any ignition coil is not within the acceptable range, replace the ignition coil. See Ignition System Repair Procedures - Ignition Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.

10. Reconnect all wires disconnected during test.

11. Return to flow chart.

15 **Test 7 - Output Tests - Engine Running**

⚠ CAUTION

The following tests must be performed with correct test propeller and with the engine in a test tank. Note that some performance problems cannot be duplicated in a test tank, in these cases the tests must be conducted with the engine mounted on a boat and operated in open water.

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

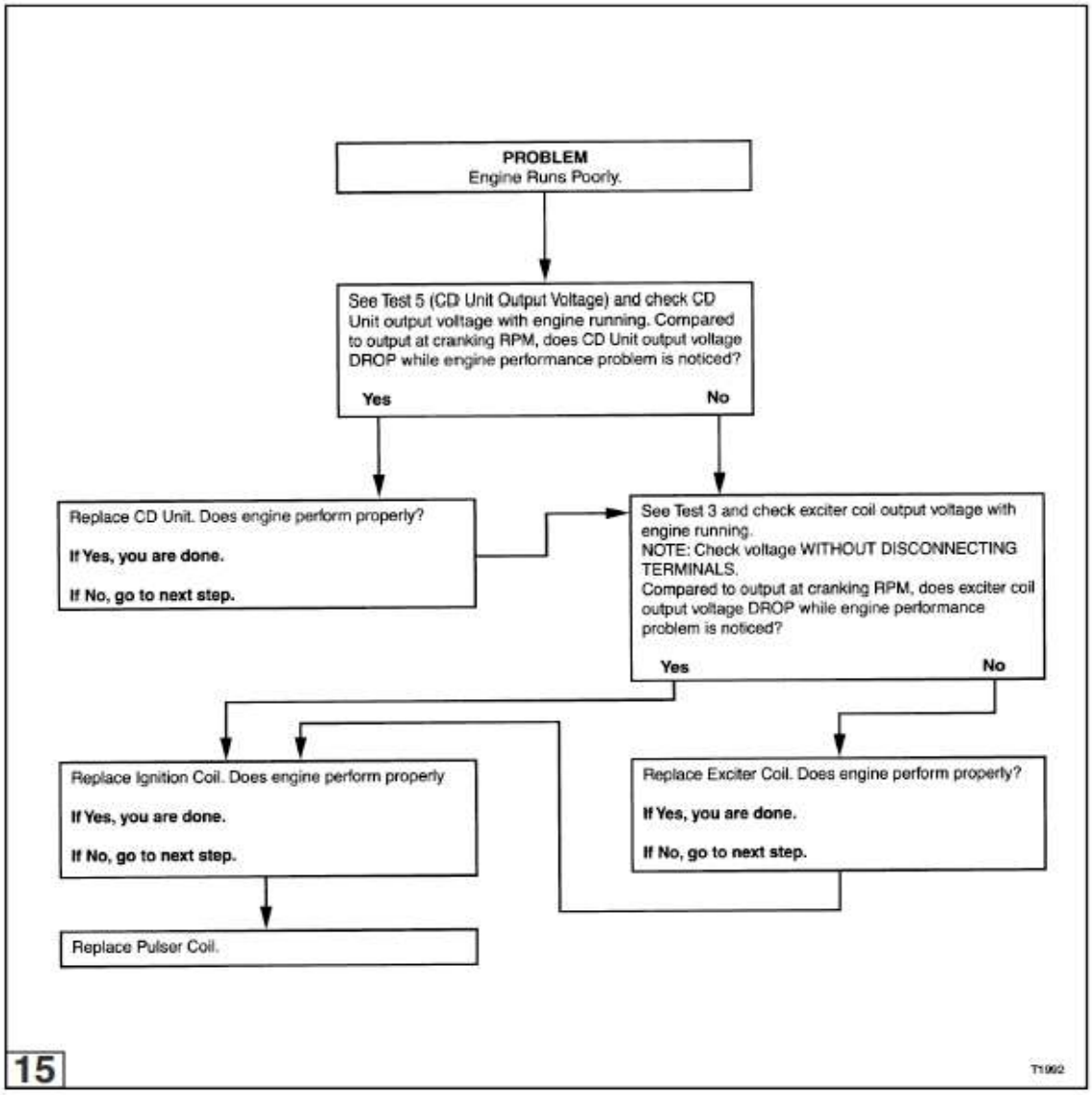
Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

These series of tests are designed to efficiently find faulty ignition components that can cause an engine to run poorly. Use the flow chart to systematically eliminate the possible causes to the problems.

The tests assume that:

- The engine starts.
- Tune-Up Procedure has been performed, see Section 2.
- Ignition Timing and the Carburetor Synchronization Procedure has been performed, see Section 2.
- Engine is at operating temperature.
- Tests are performed with engine running in forward gear.
- Tachometer is installed.

15 Output Tests - Engine Running - Flow Chart


PROBLEM
Engine Runs Poorly.
See Test 5 (CD Unit Output Voltage) and check CD Unit output voltage with engine running. Compared to output at cranking RPM, does CD Unit output voltage DROP while engine performance problem is noticed?
Yes
No
Replace CD Unit. Does engine perform properly?
If Yes, you are done.
If No, go to next step.
See Test 3 and check exciter coil output voltage with engine running.
NOTE: Check voltage WITHOUT DISCONNECTING TERMINALS.
Compared to output at cranking RPM, does exciter coil output voltage DROP while engine performance problem is noticed?
Yes
No
Replace Ignition Coil. Does engine perform properly
If Yes, you are done.
If No, go to next step.
Replace Exciter Coil. Does engine perform properly?
If Yes, you are done.
If No, go to next step.
Replace Pulser Coil.
15
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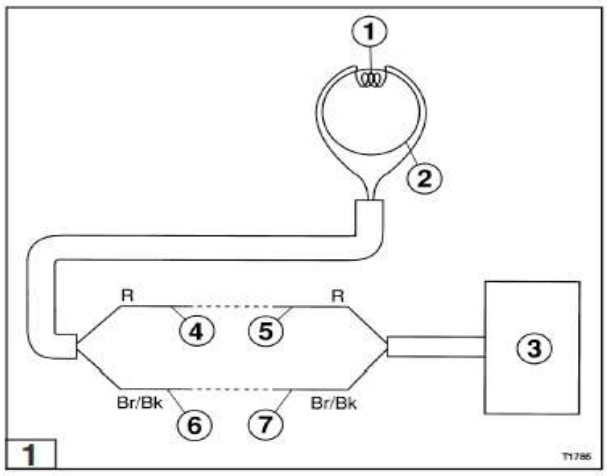
Ignition System Repair Procedures



⚠⚠ WARNING

Disable ignition system, by disconnecting exciter coil terminals (4), (5), (6), (7), to prevent accidental engine startup during removal and replacement of the flywheel.

⚠ CAUTION

Flywheel is under high torque and requires the use of special tools for removal and installation. Failure to use the specified tools can result in injury or damage to the flywheel or coil plate electrical components.

⚠ CAUTION

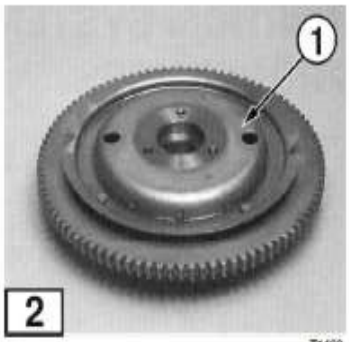
The force needed to loosen and tighten the flywheel nut requires flywheel be removed and installed with engine mounted and secured on an engine stand.

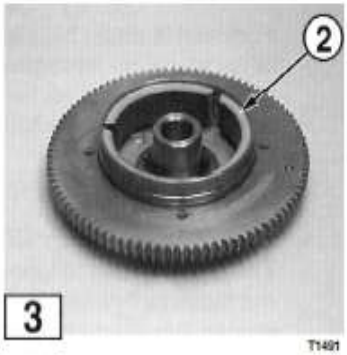
⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-in-gear prevention system must be tested before returning engine to customer.





Flywheel

Replacing the exciter coil or coil plate assembly requires the removal of the flywheel, see Section 4, Flywheel, for the proper procedure.

NOTE

Flywheel magnets must be of a particular strength in order to run the ignition system. Weak magnets can cause low ignition voltage which may affect engine performance. Flywheels seldom go bad and would only be replaced as a last resort in solving an ignition problem.

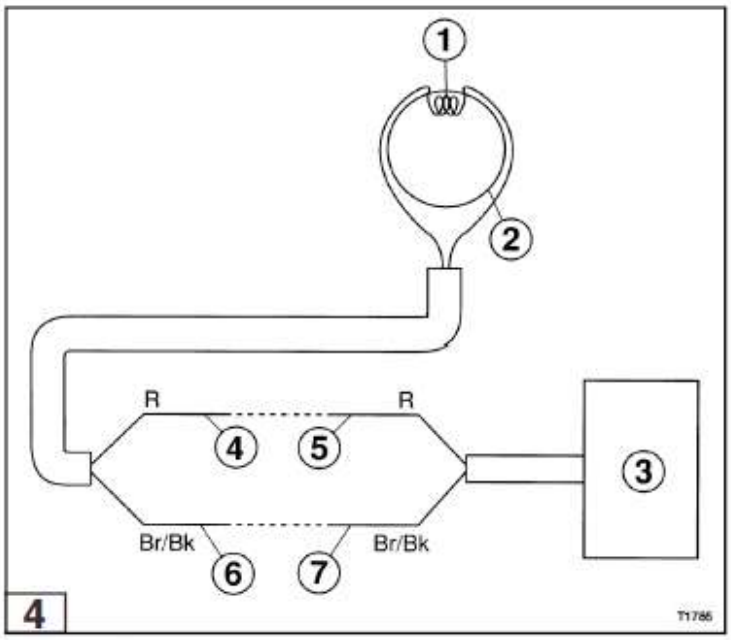
2 3 Carefully inspect flywheel **(1)** for cracks, chips, and worn taper after it is removed. Also inspect the magnets **(2)** for cracks and chips and make sure they are firmly attached to the flywheel.

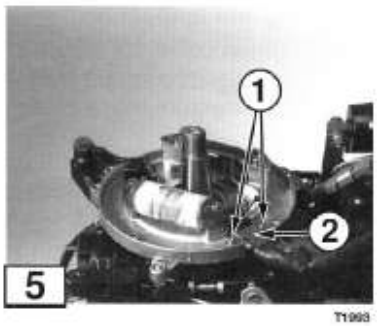
Exciter Coil

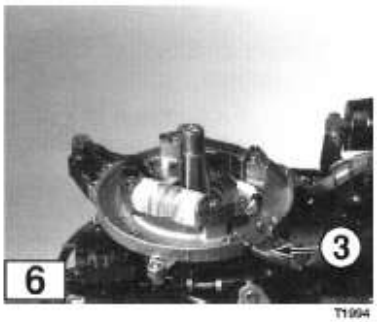
NOTE

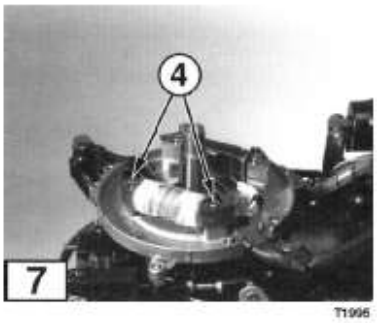
Disconnect negative battery cable from battery before removing exciter coil.

This procedure assumes exciter coil is available as a separate replaceable component. Some engine configurations might require replacement of entire coil plate assembly. Check current Parts Catalog for availability.









Removal

1. Remove the flywheel.

4 2. Disconnect terminals **(4)**, **(5)**, **(6)** and **(7)** for exciter coil **(1)** connectors. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**:

5 3. Remove coil plate assembly cable clamp screws **(1)** and cable clamp **(2)**.

6 4. For models 9.9 / 15 / 18 / 25 / 30 / 40 ONLY: Carefully slit coil plate assembly cable shield **(3)**.

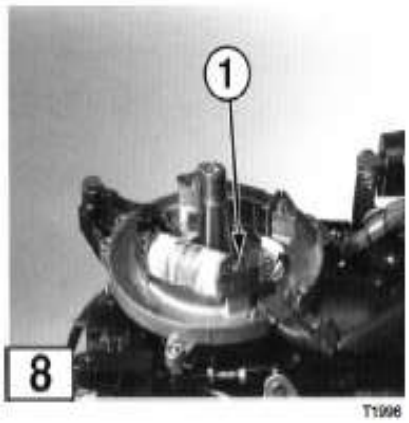
NOTE

Make sure you don't cut electrical conductors inside of coil plate assembly cable when you slit cable shield.

7 6. Remove exciter coil screws **(4)** and exciter coil from the mounting bracket.

Cleaning and Inspection

8 Clean coil plate assembly, upper main bearing seal **(1)**, set ring, ignition timing link, alternator coils, pulser coils, coil leads, and coil connectors with isopropyl alcohol as required.



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Check for the following and repair or replace as required:

- Bent, chipped, cracked, or corroded coil plate assembly.
- Coil leads for integrity, cut or cracked insulation, and damaged connectors.
- Broken or bent alternator coil Laminations damaged alternator coil windings and missing alternator coil screws.
- Broken, cracked, or misaligned pulser coils and missing pulser coil screws.

9 • Free motion of ignition timing link (1). Repair, adjust, and lubricate as needed, see Section 2.

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Installation

Install in reverse order of removal.

NOTE

Use threadlocker on screw threads before installing screws.

Use a length of shrink tube to fabricate a new coil plate assembly cable shield as required. Inside diameter of shrink tubing must be large enough to pass over the largest connector.

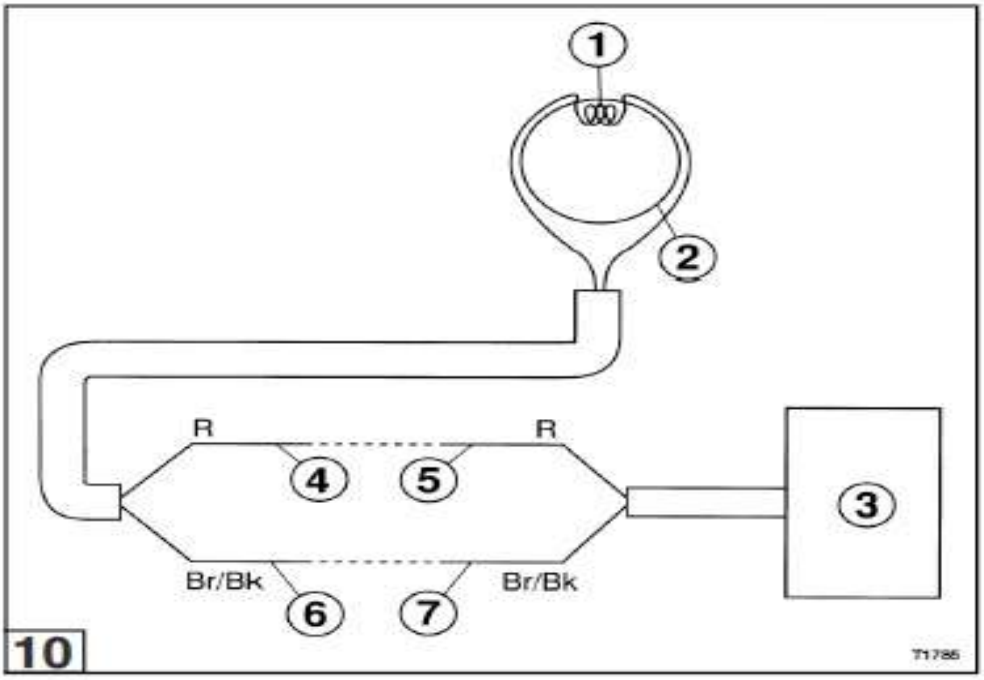
Coil Plate Assembly

Removal

1. Remove the flywheel.

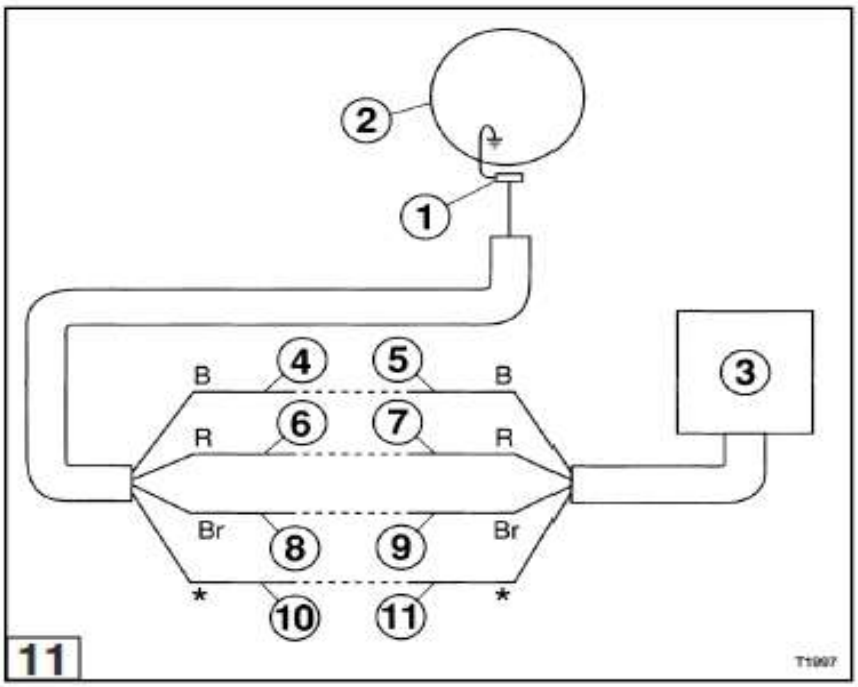
2. Disconnect the following terminals:

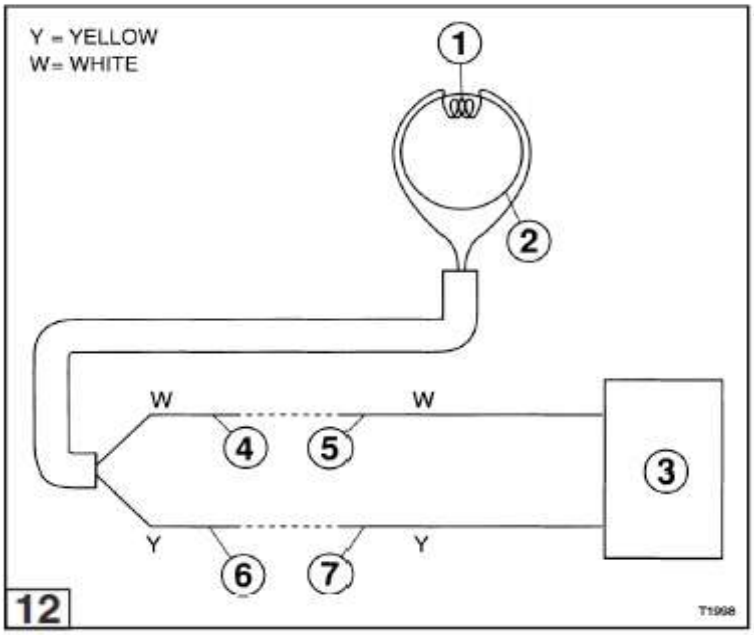
10 Exciter coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**. Disconnect terminals **(4)**, **(5)**, **(6)** and **(7)**.



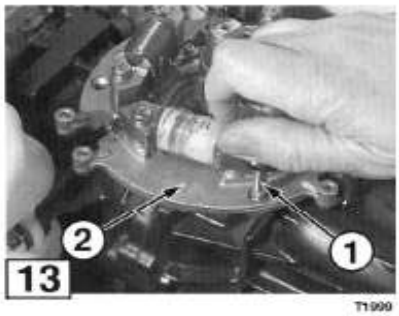
11 pulser coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**. Disconnect terminals **(4)**, **(5)**, **(6)**, **(7)**, **(8)**, **(9)**, **(10)** and **(11)**.

12 Alternator coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to rectifier/ regulator **(3)**. Disconnect terminals **(4)**, **(5)**, **(6)** and **(7)**.





13 3. Remove the screws **(1)** and remove coil plate assembly **(2)** from the set ring.



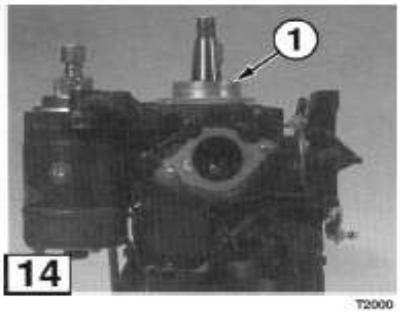
Cleaning and Inspection

14 15 Clean upper main bearing seal **(1)**, guide plate **(2)** and set ring **(3)** with dry cloth.

Check for the following and repair or replace as required:

- Bent, chipped, cracked, or corroded guide plate.
- Broken or bent set ring.

Apply light coat of low temperature lithium grease to guide plate **(2)**.



Istallation

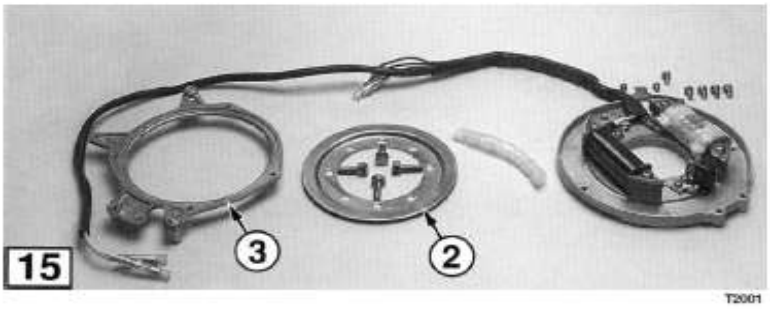
Install in reverse order of removal.

NOTE

Disconnect negative battery cable from battery before installing coil plate assembly.

Use threadlocker on screw threads before installing screws.

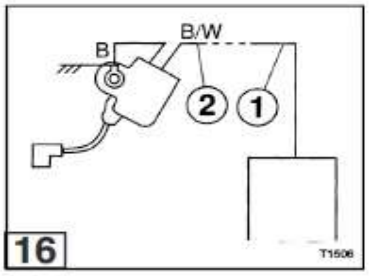
Apply light coat of low temperature lithium grease to the guide plate.

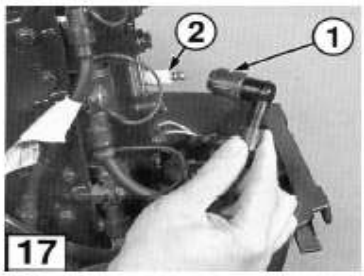


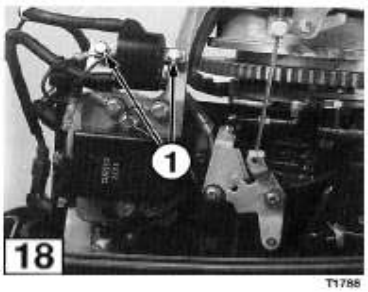
Ignition Coil

NOTE

Disconnect negative battery cable from battery before removing ignition coil.





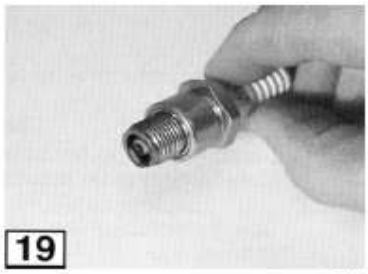


Removal

16 1. Disconnect CD Unit output lead **(1)** from ignition coil primary cable **(2)**.

17 2. Disconnect spark plug cap **(1)** from spark plug **(2)**.

18 3. Remove bolts **(1)** and remove ignition coil.



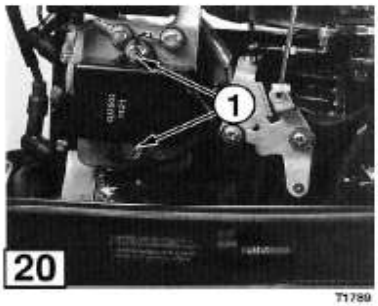
Cleaning and Inspection
Clean mounting area with isopropyl alcohol.

Check for the following and repair or replace as required:

19 Remove spark plug(s) and inspect for fouling, damaged electrodes, or damaged ceramic insulator.
CD Unit output connectors and leads for integrity, cut or cracked insulation.

Installation
Install in reverse order of removal.

CD Unit



NOTE

Disconnect negative battery cable from battery before removing CD Unit.

Removal

20 1. Remove bolts **(1)**.

2. Remove CD Unit.

Cleaning and Inspection
Examine electrical conductors and connectors.

Installation
Install in reverse order of removal.

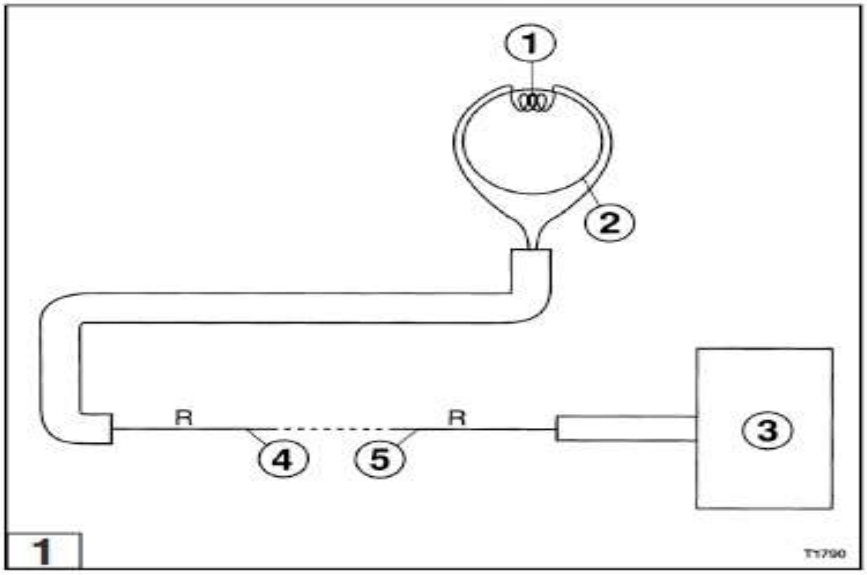
NOTE

Make sure that all electrical conductors are properly routed before you insert CD Unit to avoid pinching them.

STARTING SYSTEM

⚠⚠ WARNING

Disable ignition system, by disconnecting exciter coil terminals (4) and (5) to prevent accidental engine startup during testing of starter circuit.



⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-in-gear prevention system must be tested before returning engine to customer.

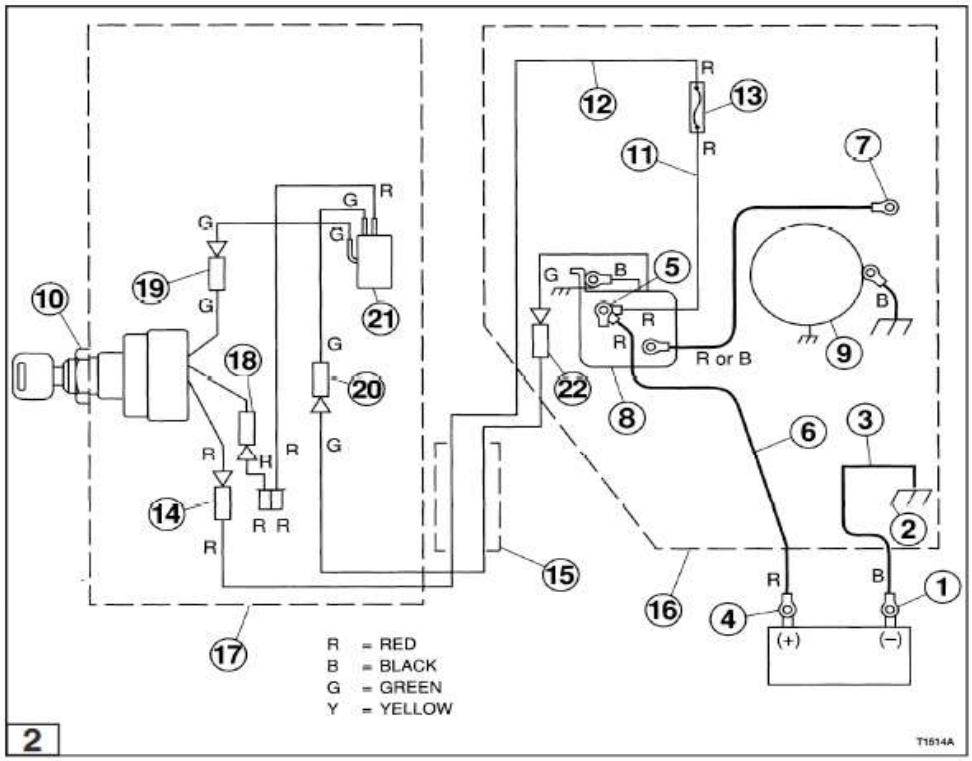
Starter System Testing

The starter system may cause three types of problems:

- The engine does not crank, see Starter Circuit Tests in this section.
- The starter motor runs but does not engage or disengage from the flywheel, see Starter Motor Test in this section.
- The starter motor will not shut off, see Starter Solenoid -Test in this section.

Before you begin testing of starting system:

- Check battery fluid level and specific gravity. Charge or replace as required. See Battery Care and Maintenance, this section.
- Check the following electrical connections and make sure they are secure and free of corrosion:
  - Batterycables and clamps.
  - Starter solenoid wiring (including ground connection).
  - Starter motor wiring (including ground connection to engine block and/or cowling).
  - Main key switch and neutral start switch cables.
- Make sure shift lever or remote control lever is in NEUTRAL and it operates freely.



2 **3** **Starter Circuit Tests**

These tests are designed to quickly isolate the faulty starter circuit component if the engine does not crank.

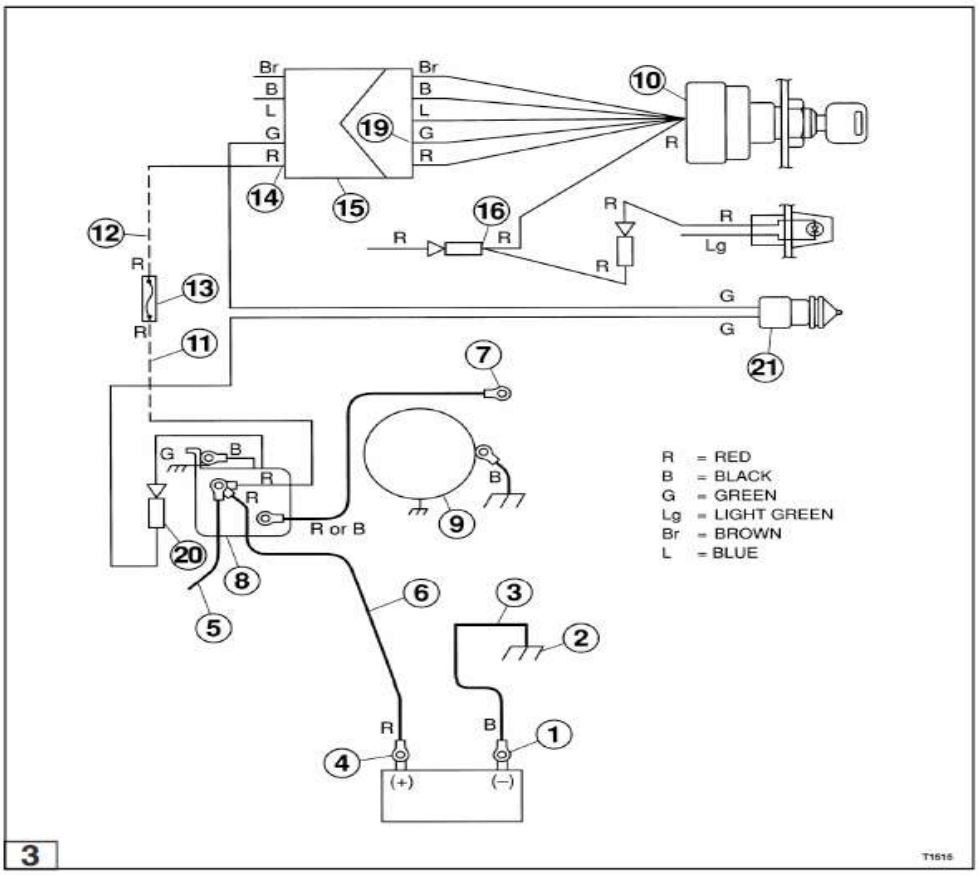
NOTE

The electrical drawings have been simplified to show only those elements necessary to test the starter circuit.

Two types of starter circuits are used and illustrated in:

2 • *Models with remote control box.*

3 • *Models without remote control box.*



3

1. Disconnect negative battery cable **(3)** from negative battery terminal **(1)**.

2. Set analog multimeter to check continuity. Connect one tester lead to negative battery terminal **(1)** and the other tester lead to the ground connection **(2)** for negative battery cable **(3)**.

If the meter does not indicate continuity, clean connections and/or replace negative battery cable.

If the meter indicates continuity, go to the next step.

3. Set analog multimeter to "iDCV" and set range to "20". Connect BLACK tester lead to "- COM" and the RED tester lead to "+ VΩ".

4. Connect BLACK tester lead to clean engine ground.

5. Connect RED tester lead to positive battery terminal **(4)**.

If meter does not indicate 11.8 to 13.2 VDC (battery voltage), see Battery Care and Maintenance, this section.

If meter indicates battery voltage go to next step.

6. Reconnect negative battery cable **(3)** to negative battery terminal **(1)**.

7. Connect RED tester lead to starter solenoid terminal **(5)**.

If meter does not indicate battery voltage, replace battery cable **(6)**.

If meter indicates battery voltage go to next step.

8. Disconnect lead **(7)** from starter solenoid **(8)** to starter motor **(9)**.

9. Connect RED tester lead to starter solenoid lead **(7)** and turn main key switch **(10)** to START position.

If meter indicates battery voltage, repair or replace starter motor, see Starter Motor Tests in this section.

If meter does not indicate battery voltage, go to next step.

10. Connect RED tester lead to connector closest to fuse holder **(11)**.

If meter does not indicate battery voltage, repair or replace cable between **(5)** and **(11)**.

If meter indicates battery voltage, go to next step.

11. Connect RED tester lead to connector closest to fuse holder **(12)**.

If meter does not indicate battery voltage, find source of overload or short and replace 15 A engine fuse **(13)**. Possible sources of short or overload:

- Short in starter circuit wiring or components, such as starter solenoid, main key switch, or neutral start switch.
- Short in charging circuit wiring or components, such as the alternator coils or rectifier/regulator.
- Short in accessories.
- Short in starter motor.

If meter indicates battery voltage, go to next step.

12. Connect RED tester lead to connector closest to main key switch **(14)**.

NOTE

*For models with remote control box - Make sure you test the correct terminal in this step. Terminal **(14)** is connected directly to the main key switch **(10)** and the RED lead that comes out of the large cable **(15)** that connects the engine compartment **(16)** to the remote control box **(17)**. DO NOT CONFUSE TERMINAL **(14)** WITH TERMINAL **(18)**.*

NOTE

*For models without remote control box - You might have to pull connector **(15)** apart and measure voltage at terminal.*

Make sure you test the correct terminal in this step.

If meter does not indicate battery voltage, repair or replace cable between (12) and (14).

If meter indicates battery voltage, go to next step.

13. Connect RED tester lead to main button starter switch and push Raider start button.

14. Connect RED tester lead to neutral start switch lead **(20)** and turn main key switch **(10)** to START position.

If meter does not indicate battery voltage, test neutral start switch **(21)**. Refer to Neutral Start Switch Test in this section.

If meter indicates battery voltage, go to next step.

15. For models with remote control box ONLY - Connect RED tester lead to starter solenoid lead **(22)** and turn main key switch **(10)** to START position.

If meter does not indicate battery voltage, repair or replace cable between **(20)** and **(22)**.

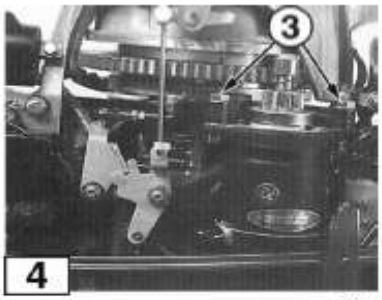
If meter indicates battery voltage, go to next step.

16. Connect RED tester lead to starter solenoid lead **(7)** and turn main key switch **(10)** to START position.

If meter does not indicate battery voltage, test starter solenoid **(8)**. Refer to Starter Solenoid Test in this section,

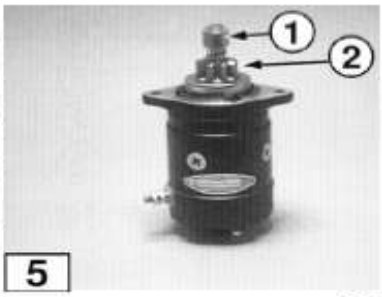
Starter Motor Tests

- If the engine does not crank and you completed the Starter Circuit Tests previously described, remove the starter motor and inspect the brush assembly. If the brush assembly meets specifications, replace the starter motor or have it rebuilt.
- If the starter motor runs but the starter motor does not engage or disengage from the flywheel, remove the starter motor and inspect the pinion assembly. If the pinion assembly meets specifications, inspect the flywheel for chipped or worn teeth and replace as needed.



4

T2214



5

T2215

Remove Starter Motor

NOTE

Disconnect negative battery cable from battery before removing starter motor.

4 1. Disconnect starter solenoid cable and ground cable.

2. Remove starter motor bolts **(3)**.

3. Slide starter motor out of bracket.

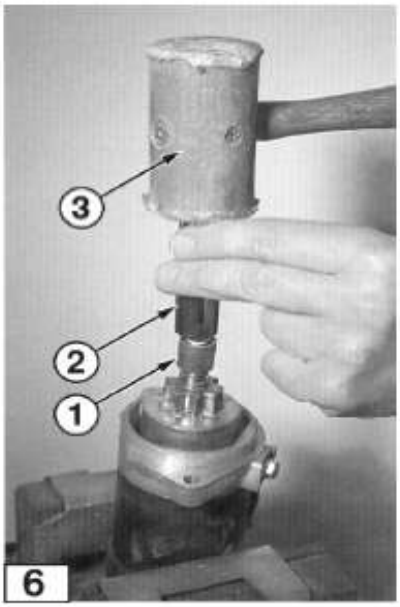
4. Clean bracket with cleaning solvent.

Inspect and Remove Pinion Assembly

5 1. Grasp pinion collar **(1)** and wind pinion gear **(2)** in a clockwise direction. Make sure gear moves freely and returns to original position. If any binding is noted, remove and replace pinion assembly.

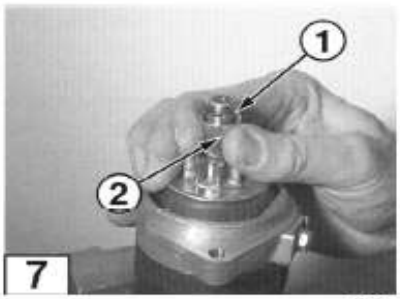
6 2. Release pinion collar **(1)** by tapping it with a socket **(2)** (with same outside diameter as pinion collar and clearance for motor shaft) and mallet **(3)**.

7 3. Push down on pinion collar (2) and remove locking ring **(1)**.



6

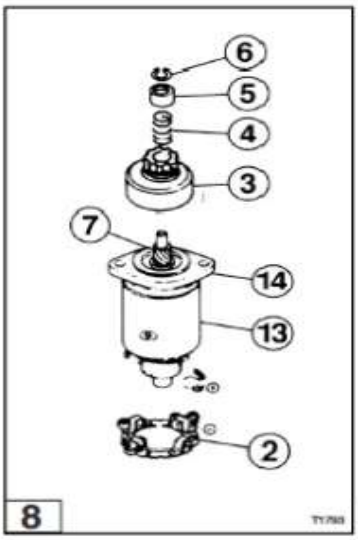
T1522

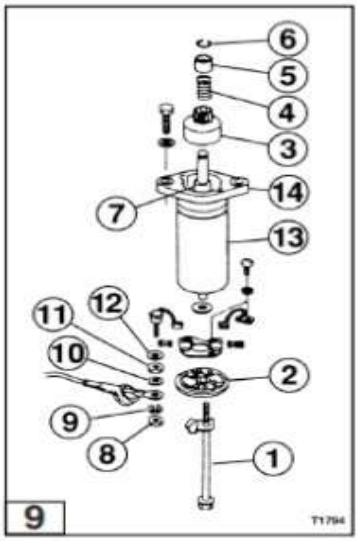


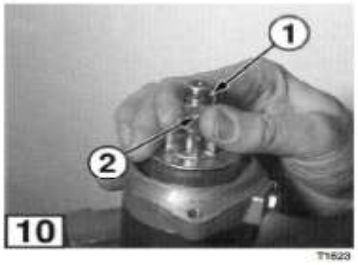
7

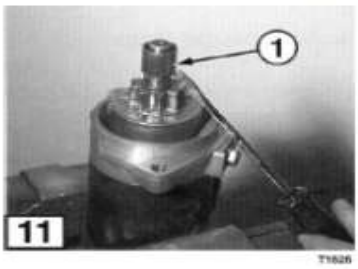
T1523

Note: After disassembly prior to assembly spray “Corrosion Zero” on all parts.









8 9 4. Remove pinion gear **(3)**, spring **(4)** and pinion collar **(5)**.

5. Clean removed components with cleaning solvent and examine pinion gear for wear and chipped teeth and spring for tension or distortion and replace assembly as required.

NOTE

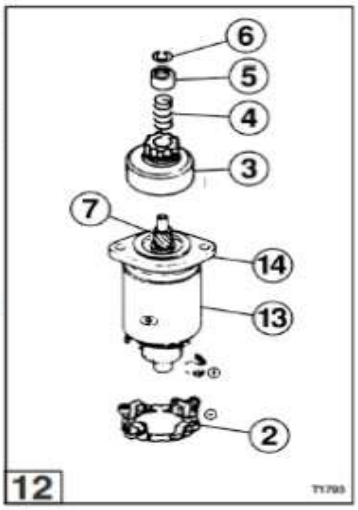
Do not allow cleaning solvent to come in contact with starter motor.

6. Apply a light coat of low temperature lithium grease to motor shaft **(7)** and slide on pinion gear **(3)**, wind counterclockwise to seat.

7. Slide spring **(4)** and pinion collar **(5)** on motor shaft **(7)**.

10 8. Push down on pinion collar **(2)** and install locking ring **(1)**.

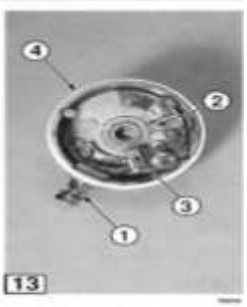
11 9. Tap pinion collar **(1)** in place.



Disassemble Starter Motor

9 12 1. Remove bolts **(1)**.

2. Remove motor base **(2)**.



Inspect Brush Assembly

13 1. Clean starter motor terminal and hardware **(1)** with isopropyl alcohol and fine emery cloth and replace brush assembly if terminal or hardware cannot be restored to original condition.

13 **14** **15** 2. Check brushes **(2)** and **(3)** for chips, fractures, and wear. If not within specifications, replace brush assembly:

The Raider 40 Original Length (a) is 0.295 inches (7.5 mm). Repair Limit (b) is 0.177 inches (4.5 mm).

3. Check spring tension. If springs are weak, replace brush assembly.

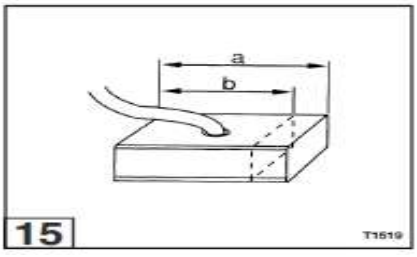
4. Check continuity with analog multimeter between:

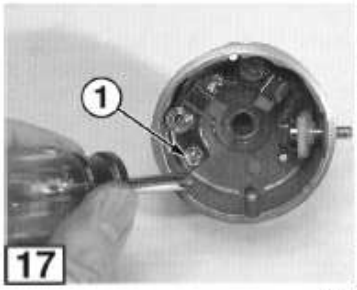
Brush **(2)** and **(3)**. Replace brush assembly if meter indicates continuity.

Brush **(3)** and the motor base **(4)**. Replace brush assembly if meter indicates continuity.

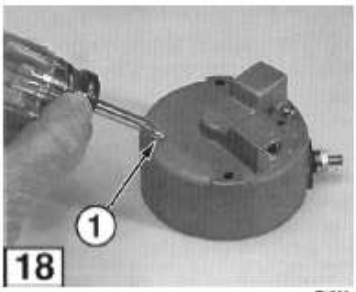
Brush **(3)** and the starter motor terminal **(1)**. Replace brush assembly if meter does not indicate continuity.

Brush **(2)** and the motor base **(4)**. Replace brush assembly if meter does not indicate continuity.

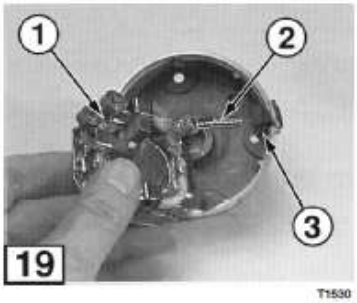




T1628



T1629



T1630

Remove Brush Assembly

17 18 1. Remove screws **(1)**.

19 Remove brush assembly **(1)** carefully guiding the starter motor terminal **(2)** through the bushing **(3)**.

Install Brush Assembly

20 1. Apply genuine grease to bearing cup **(1)**.

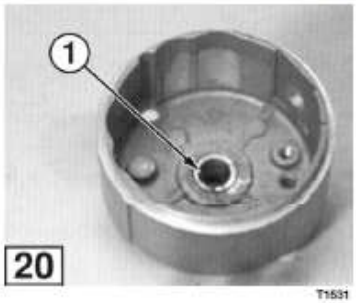
21 2. Install brush assembly **(1)**. Make sure that the starter motor terminal **(2)** is fully seated in the bushing **(3)**.

Assemble Starter Motor

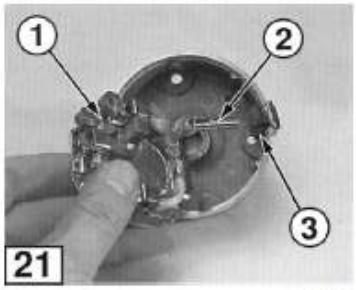
NOTE

Bolts for models 25 / 30 / 40 may not be available as separate parts. Check current Parts Catalog for availability.

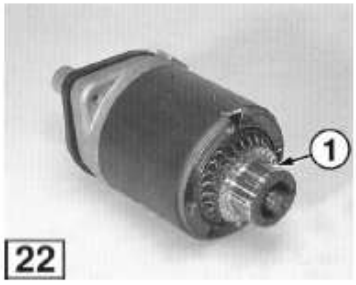
22 1. Clean commutator **(1)** with fine emery cloth.

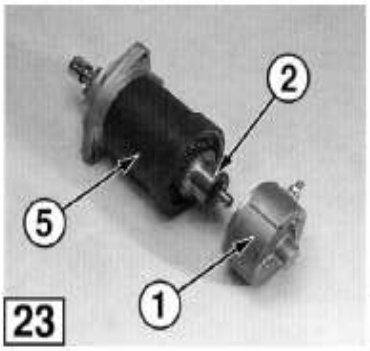


T1631

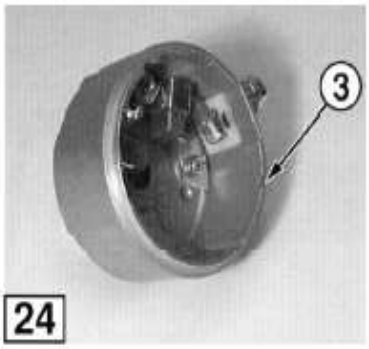


T1630

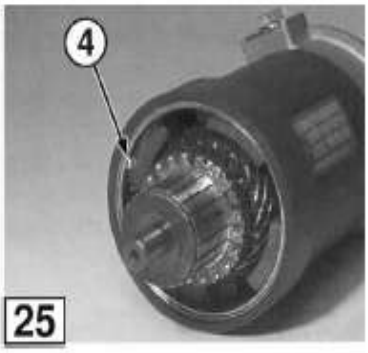




T1533



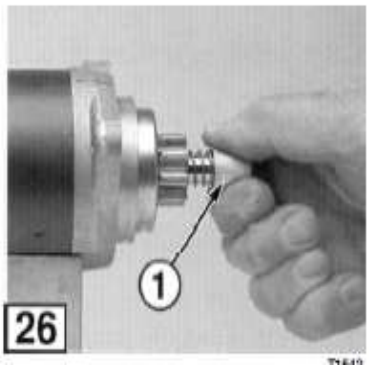
T1536



T1537

23 24 25 2. Retract brushes as you slide motor base **(1)** over commutator **(2)**. Align notch **(3)** in motor base with tab **(4)** in motor body **(5)** and seat motor baseto motor body.

26 3. Grasp pinion collar **(1)** and rotate several times to make sure brushes are seated.



Install Starter Motor

29 1. Slide starter motor into bracket, apply threadlocker to bolt threads, and install mounting bolts.

2. Connect starter solenoid cable and ground cable.

3. Coat terminals with battery spray protector.

Starter Solenoid Test

30 1. Disconnect terminals **(4)** and **(5)** and disconnect terminal **(3)** from chassis ground.

T1796

2. Set analog multimeter for continuity. Check for continuity between terminals:

(3) and **(5)**. If meter does not show continuity, replace starter solenoid **(1)**.

(5) and clean chassis ground. If meter shows continuity, replace starter solenoid.

(3) and clean chassis ground. If meter shows continuity, replace starter solenoid.

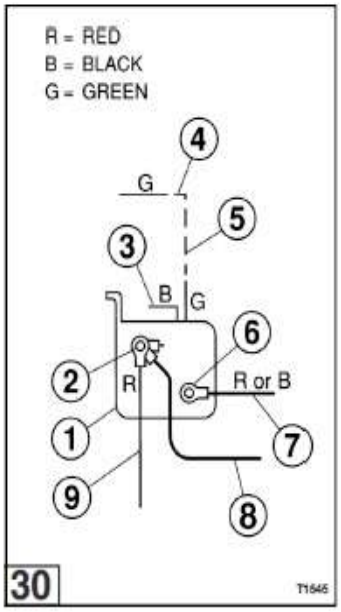
3. Disconnect positive battery lead **(8)** and RED starter switch lead **(9)** from starter terminal **(2)** and disconnect starter motor lead **(7)** from starter terminal **(6)**.

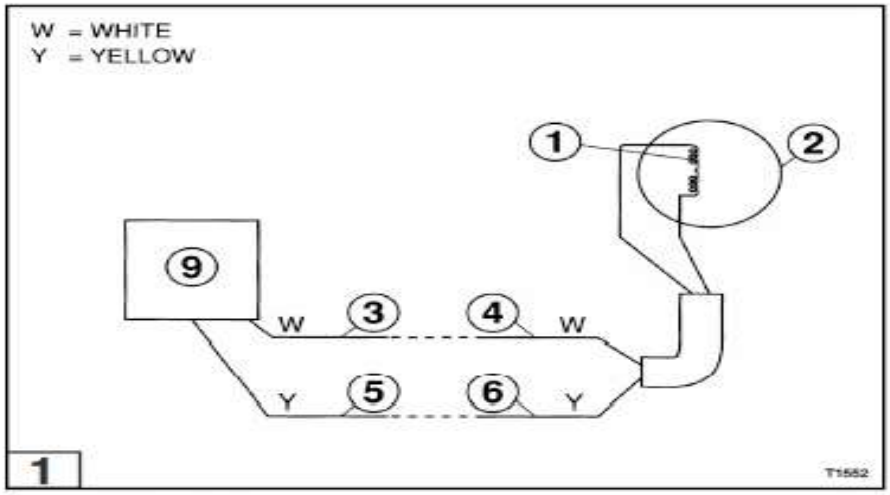
4. Check for continuity between terminals:

(2) and **(6)**. If meter shows continuity, replace starter solenoid.

(2) and clean chassis ground. If the meter shows continuity, replace starter solenoid.

(6) and clean chassis ground. If the meter shows continuity, replace starter solenoid.





Alternator Coil Tests

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the alternator coil test, The pulser and exciter coils have been removed from both illustrations for clarity.

1 The alternator coil test is used to determine whether the alternator coils **(1)**, located on the coil plate assembly **(2)** are open or shorted.The output from the alternator coil goes to the rectifier/regulator **(9)**.

1 1. Disconnect terminals **(3)**, **(4)**, **(5)** and **(6)**.

1 2. Set the digital multimeter to ohms and connect the leads between terminals **(4)** and **(6)** to read the resistance of the alternator coil.

The meter should indicate the following resistance: Y-W: 0.65 – 0.98

Y-B : 0.31 – 0.47
W-B: 0.37 – 0.55

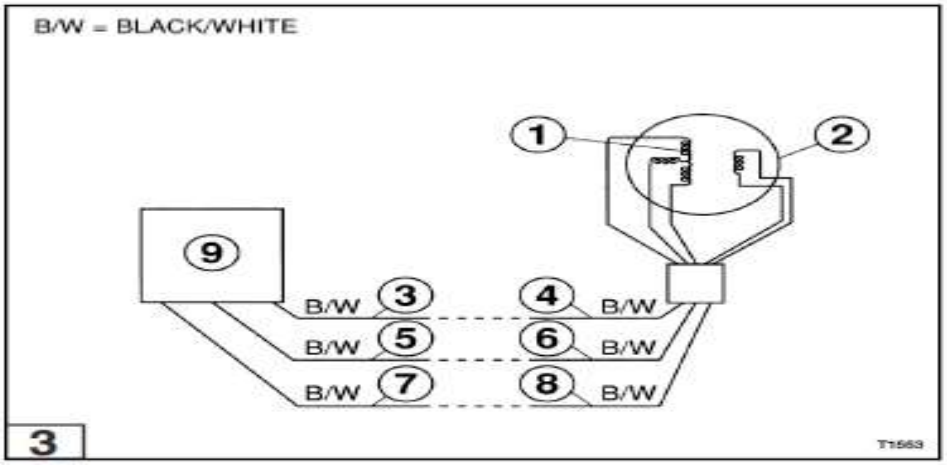
4. If the resistance is not within the indicated range, replace the alternator coils. See Charging System Repair Procedures - Alternator Coils.

If the resistance is within the indicated range, proceed to the next step.

2 3 5. Connect one tester head to a clean engine ground and connect the other tester lead to terminals **(4)** and **(6)** (one terminal at a time) to check for any resistance to ground:

6. If the meter indicates any resistance to ground, replace the alternator coils. See Charging System Repair Procedures - Alternator Coils.

If the meter does not indicate any resistance to ground, proceed to the next step.



7. Set the analog multimeter to "40" on the "ACV" scale.

8. Insert the banana plug of the RED tester lead into the meter connection labeled "+VΩ" and the banana plug of the BLACK tester lead into the meter connection labeled "-COM".

3 9. Connect the BLACK tester lead to a clean engine ground and the RED tester lead to terminals **(4)** and **(6)** (one terminal at a time) to check for any voltage to ground:

10. Start engine.

11. At idle and full throttle, if the meter indicates any voltage to ground, replace alternator coils. See Charging System Repair Procedures - Alternator Coils.

If no voltage to ground is indicated, the test is complete.

12. Reconnect alternator terminals.

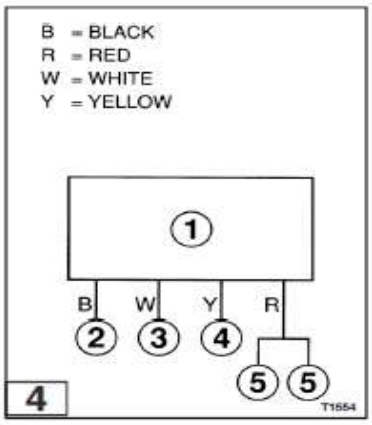
Rectifier/Regulator Tests

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check ior continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the rectifier/regulator test.



The rectifier/regulator tests check whether the rectifier/regulator **(1)** is shorted or open.

1. Disconnect terminals **(2)**, **(3)**, **(4)** and **(5)** from all other wiring:

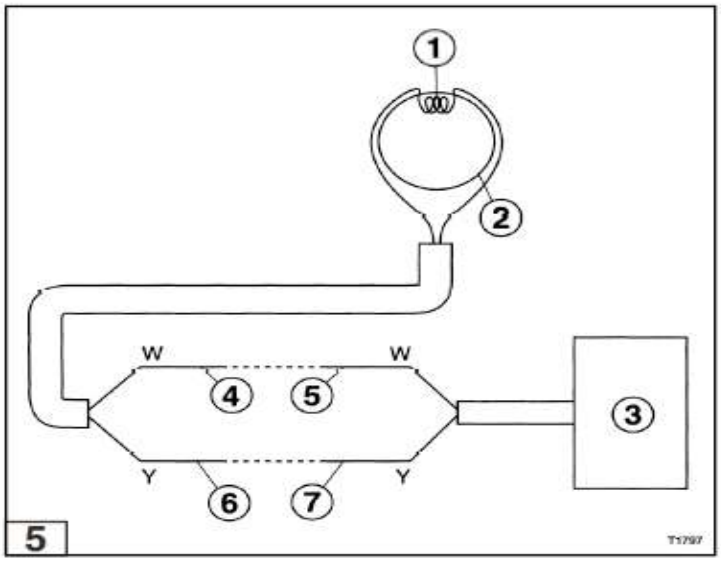
2. Set analog multimeter to check continuity.

3. Insert the banana plug of the RED tester lead into the meter connection labeled "+VΩ" and the banana plug of the BLACK tester lead into the meter connection labeled "-COM".

4. Connect the RED and BLACK tester leads to the terminals as shown and note the results:

- Follow the tests listed in the chart starting at the TOP of each COLUMN and going DOWN.
- Follow the tests listed in the chart starting at the LEFT of each ROW and going to the RIGHT.

Replace rectifier/regulator if continuity tests are not as shown. If continuity checks are within specifications, proceed to next step.



NOTE

Continuity on chart means that the meter showed continuity (some resistance indicated by meter - exact value depends on test conditions). No Continuity on chart means that meter had no deflection.

		RED Tester Lead			
		Terminal (2)	Terminal (3)	Terminal (4)	Terminal (5)
BLACK Teste Lead	Terminal (2)	NA	Continuity	Continuity	Continuity
	Terminal (3)	NO Continuity	NA	NO Continuity	Continuity
	Terminal (4)	NO Continuity	NO Continuity	NA	Continuity
	Terminal (5)	NO Continuity	NO Continuity	NA	NA

5. Connect rectifier/regulator leads.

Charging System - Repair Procedures

5

⚠⚠ **WARNING**

Disable ignition system, by disconnecting exciter coil terminals (4), (5), (6), (7), to prevent accidental engine startup during removal and replacement of the flywheel.

⚠ CAUTION

Flywheel is under high torque and requires the use of special tools for removal and installation. Failure to use the specified tools can result in injury or damage to the flywheel or coil plate electrical components.

⚠ CAUTION

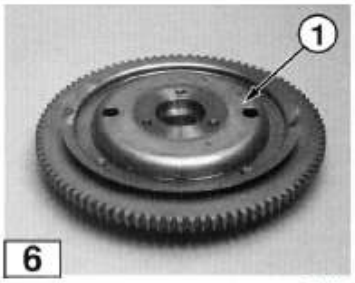
The force needed to loosen and tighten the flywheel nut requires flywheel be removed and installed with engine mounted and secured on an engine stand.

⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-in-gear prevention system must be tested before returning engine to customer.



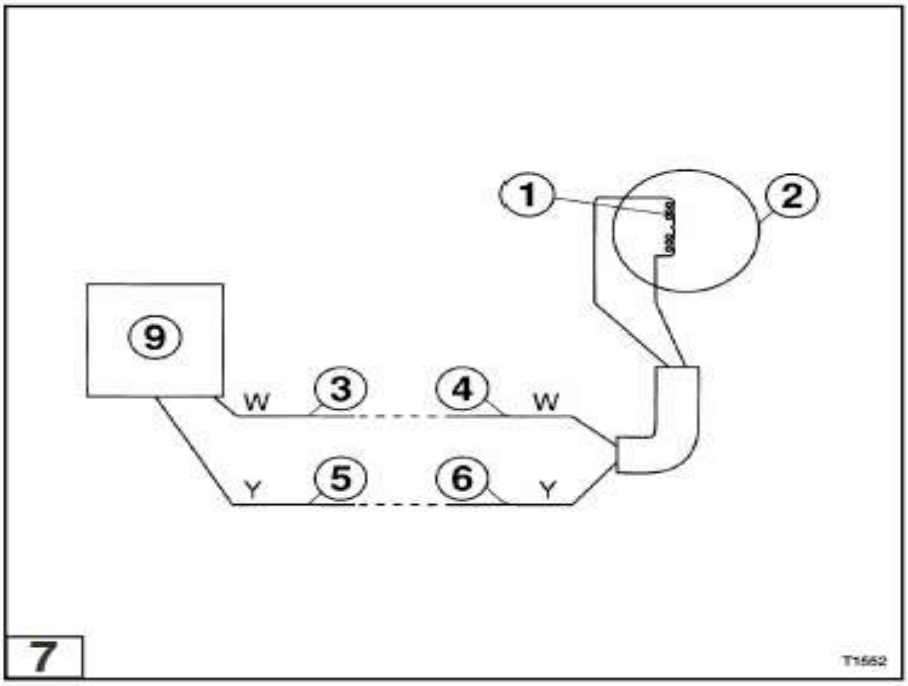
Flywheel

Replacing the exciter coil or coil plate assembly requires the removal of the flywheel, see Section 4, Flywheel, for the proper procedure.

NOTE

Flywheel magnets must be of a particular strength in order to run the ignition system. Weak magnets can cause low ignition voltage which may affect engine performance. Flywheels seldom go bad and would only be replaced as a last resort in solving an ignition problem.

6 Carefully inspect flywheel **(1)** for cracks, chips, and worn taper after it is removed. Also inspect the magnets for cracks and chips and make sure they are firmly attached to the flywheel.



Alternator Coils

NOTE

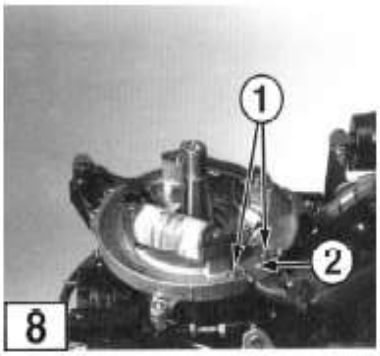
Disconnect negative battery cable from battery before removing alternator coils.

This procedure assumes alternator coils are available as a separate replaceable component. Some engine configurations might require replacement of entire coil plate assembly. Check current Parts Catalog for availability.

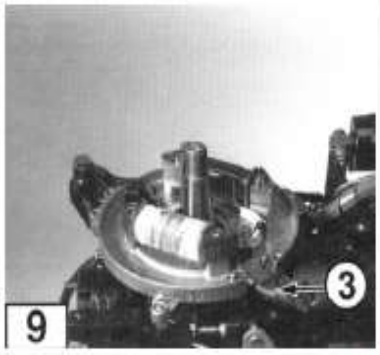
Removal

1. Remove the flywheel.

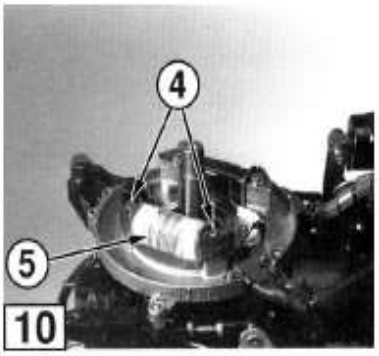
7 2. Disconnect terminals **(3)**, **(4)**, **(5)** and **(6)** for alternator coils **(1)**. Alternator coils are located on the coil plate assembly **(2)**.



T1993



T1994



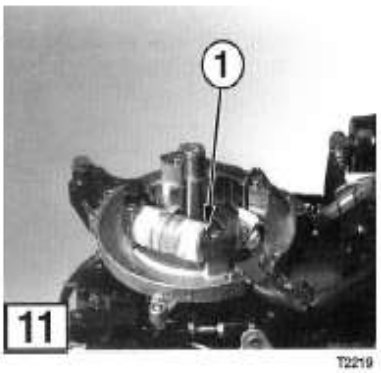
T2218

8 3. Remove coil plate assembly cable clamp screws **(1)** and cable clamp **(2)**.

NOTE

Make sure you don't cut electrical conductors inside of coil plate assembly cable when you slit cable shield.

9 : Carefully slit coil plate assembly cable shield **(1)**.



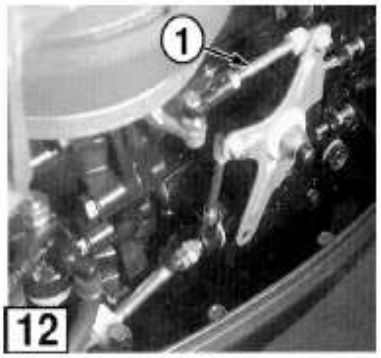
T2219

NOTE

Make sure you don't cut electrical conductors inside of coil plate assembly cable when you slit cable shield.

5. : Cut tie wrap.

10 6. Remove alternator coil screws **(4)** and alternator coil **(5)** from the mounting bracket.



T1798

Cleaning and Inspection

11 Clean coil plate assembly, upper main bearing housing, set ring, ignition timing link, exciter coil, pulser coil, coil leads, and coil connectors with isopropyl alcohol as required.

Check for the following and repair or replace as required:

- Bent, chipped, cracked, or corroded coil plate assembly.
- Coil leads for integrity, cut or cracked insulation, and damaged connectors.
- Broken or bent exciter coil laminations, damaged exciter coil windings, and missing exciter coil screws.
- Broken, cracked, or misaligned pulser coils and missing pulser coil screws.

12 • Free motion of ignition timing link **(1)**, Repair, adjust, and lubricate as needed. see Section 2.